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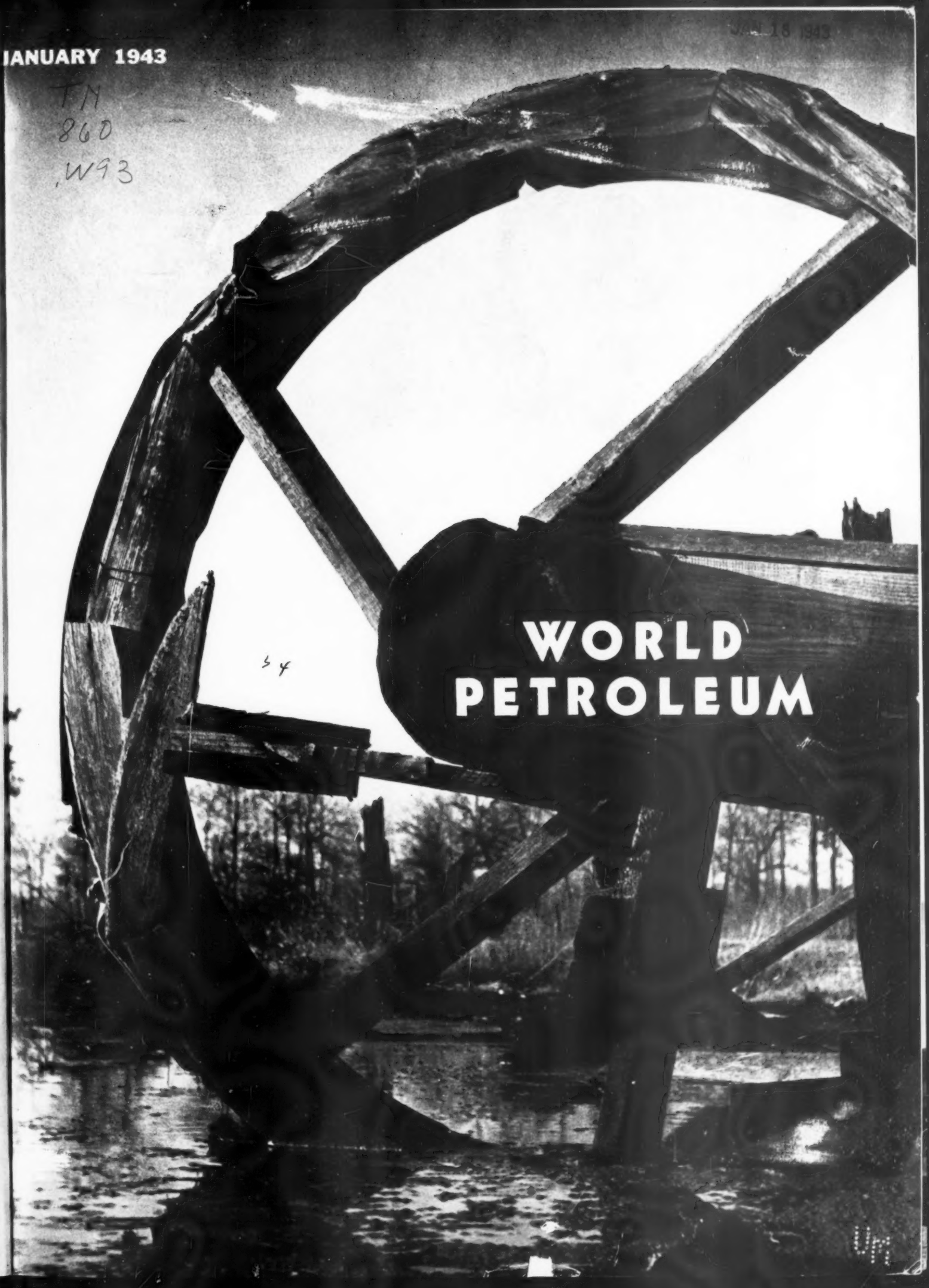

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THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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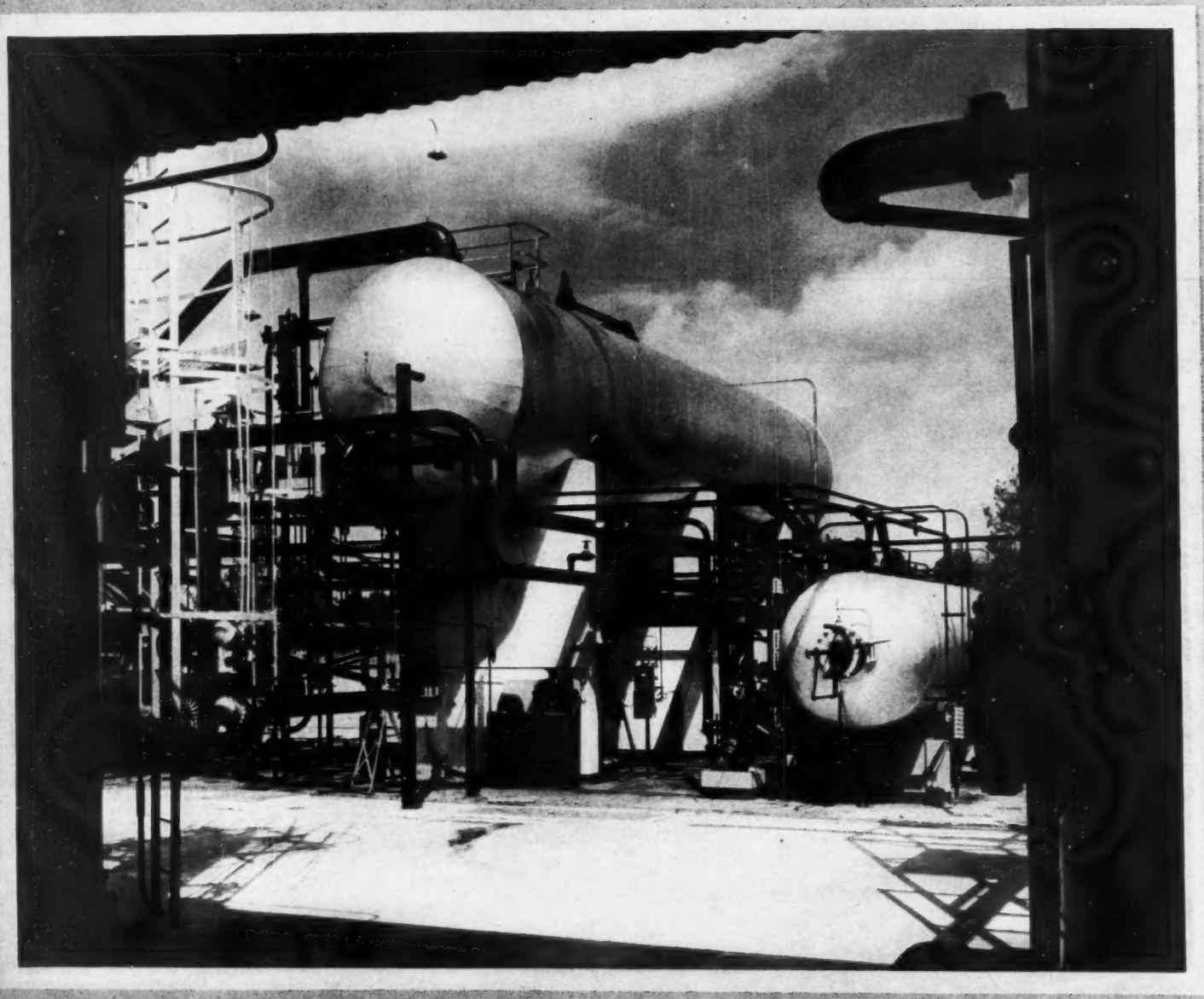


E D A L

PRESERVING THE AMERICAN WAY OF BUSINESS LIFE

BY common agreement the purpose of the United States in participating in the present war is to preserve the American way of life. What does this phrase mean; what is this way of life that is worth fighting and dying for? What are its outward manifestations and what the inner forces responsible for it? There are many possible answers but if we stop to analyze them we shall find them expressed in substance by the words freedom and opportunity—the right of every individual to chart his own course in life and to follow it to the extent of his ability. And if we seek further to find the attribute that makes these possessions so precious to us we find that it resides in the spirit of initiative.

Initiative is the one thing that is denied to those who live under Totalitarian rule. The subject is told what he may and may not do, even what he shall think and where or whether he may worship according to his faith. In the world of industry this denial of initiative finds expression in regimentation and socialization, in usurpation by the State of the functions and activities which in a democratic system are exercised according to the will of the individual.

Under the stress of war when many of the freedoms to which we are accustomed are surrendered in order that our combined strength may be exerted more powerfully, it is important to keep in mind the distinction between those sacrifices which will fortify us in the attainment of our common goal and those which will permanently weaken the foundation on which our progress toward independence of thought and action, material comfort and spiritual satisfaction is based. In order to win the war we submit to many exactions that would be resisted fiercely under normal conditions. We deprive ourselves in order that those who follow our flag and others who fight under allied banners may have food and fuel and more and better tools of war. We shoulder almost unbearable burdens of taxation, convert our activities to new channels or see our businesses completely wiped out, all without complaint. But we do it in order to avoid a greater loss, the heritage of freedom that our fathers built and handed down to us here in America. The one sacrifice we need not and should not make is the goal of all that we are fighting for—the rights of the individual, the spirit of initiative, the thing that we refer to broadly as the American way of life.

These possessions are in danger we know. Power grows by what it feeds upon and there are those in places of authority who become so enamored of systems of centralized control that they would spread them to cover the entire field of industrial effort, leaving out of account the human factor involved. Even in time of war, however, the preservation of private endeavor is more effective than the substitution of government management. Witness the magnificent job done by American railroads in the present conflict as compared with the breakdown in World War I under a far less onerous burden of transportation when the government made the mistake of taking their operation into its own hands.

Petroleum's participation in the war effort, the full measure of which is known only to those acquainted with the extent of the demands made upon it and the obstacles that have had to be overcome, is another case in point. The oil industry has radically changed its operating methods, has reconstituted its transportation system, has taken on the responsibility of providing new and highly essential products, has shouldered enormous losses and has seen a great part of its most profitable business taken away. Although probably the most highly competitive business in the country, its members have worked together without friction, exchanging products, cherished patents and processes, pooling its wholesale distribution facilities and accepting other far-reaching limitations upon its ordinary field of operations. All this has been done willingly because it was recognized as being for the good of the cause but it would be senseless and actually harmful to ask oil companies to submerge their identity, abandon the trade names that are the hallmark of individuality and sacrifice the public good will that has been built up over a long period of years. In their direct contacts with consumers, represented by the retail distribution of their products, the organizations already trained and established can function more effectively than any substitute agency, just as in the case of the railroads cited above.

The oil industry has been fortunate in that the Petroleum Administrator has made it clear from the beginning that he was relying upon team work for results rather than upon the arbitrary imposition of governmental authority. It is important that this relationship be preserved and the way kept open for restoration of full freedom of action after the present emergency has passed.

Alkylation reactor at one of the Continental Oil Company's refineries. Photo by Ulric Meisel.

OIL INDUSTRY MOVES DEEPER INTO WAR

By William R. Boyd, Jr.
President, American Petroleum Institute
Chairman, Petroleum Industry War Council

Rising Military Demands Impose Heavier Burdens and Absorb More and More of Total Oil Facilities—Having Accomplished the Seemingly Impossible the Industry Moves on to the Unbelievable.

William R. Boyd, Jr.

WHEN General Montgomery was chasing Rommel recently, it took the exclusive services of a 1,000-gallon gasoline truck to keep each one of his tanks supplied with fuel.

If 1,000 two-engine Allied bombers raid only 400 miles into Europe from England, they will use more than 400,000 gallons of aviation fuel, not counting any used by a fighter-plane escort.

In a recent advance of Allied troops, two-thirds of the tonnage of all supplies for that army were petroleum products.

This supplying of petroleum to our armed forces and to our allies on all the battlefronts of the world has become a tremendous job, and it is growing every day as we chase the Axis dogs back closer and closer to their holes. This war is of, with, and for oil, and the supply for our side obviously is our first concern. Victory is worth all the many dislocations in civilian supply, the rationing of gasoline and heating oil where it is necessary, and the sacrifices which the industry itself has made in the first year of the war.

So far America's oil industry and Petroleum Administrator for War, Harold Ickes, have teamed to furnish all the petroleum asked for by our armed forces, where and when they needed it.

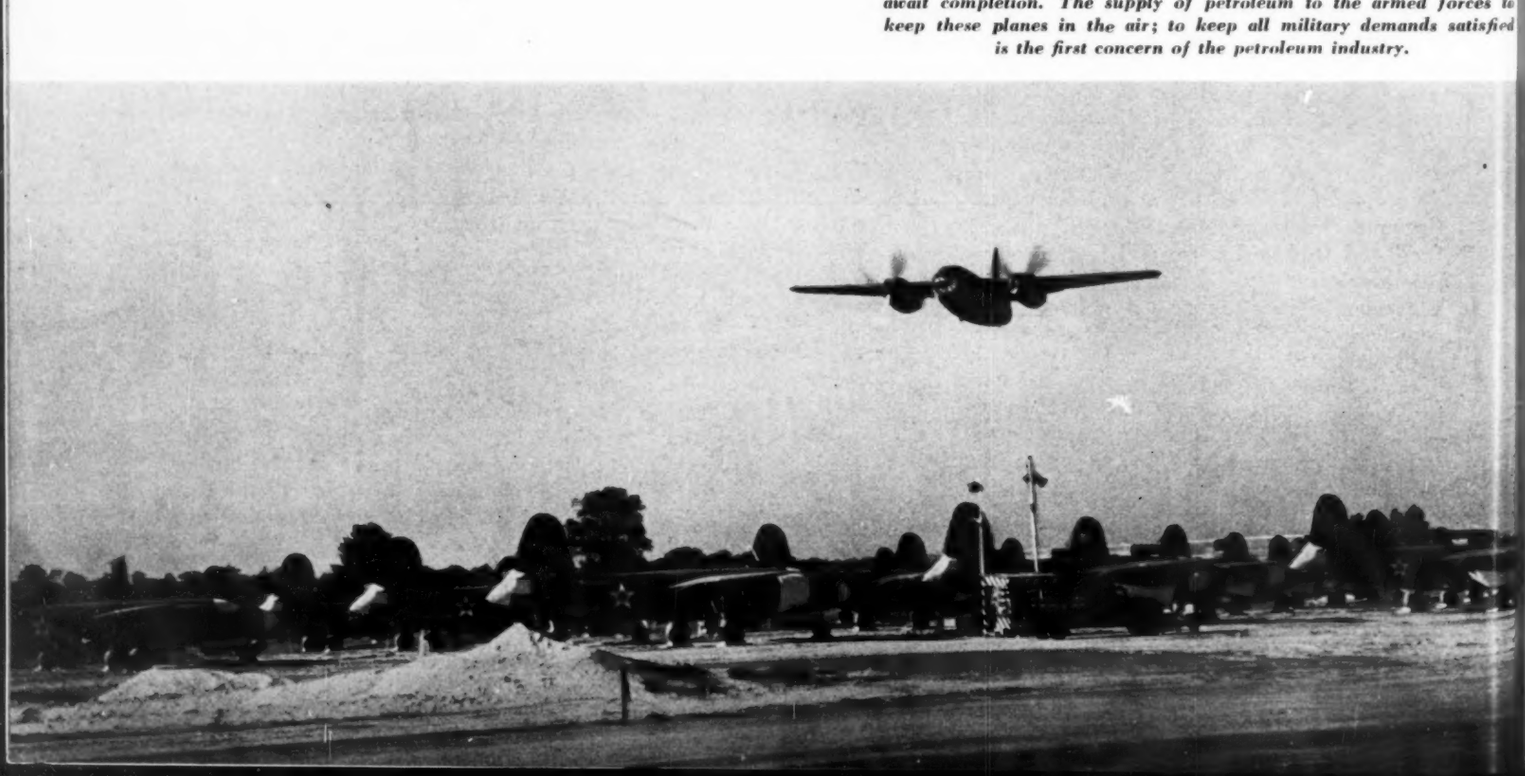
Some of the sideshows where motorists and other civilian users of petroleum are gathered have not been such good shows as they used to be. But in the big top, where our sons and brothers are taking part in the main event, the shows are going right on schedule.

Virtually every normal petroleum product is a war product now, and on top of the military needs for these regular products have come rapidly increasing demands for the new petroleum synthetics. Three of them—100-octane aviation gasoline, toluene for explosives, and raw materials for synthetic rubber—are of almost equal critical importance. The government decides which must come first Not only have we built —and are still building—scores of new plants to make these products, but many of our present refineries, under the guidance of the Petroleum Administration, have joined in a far-flung refinery conversion program that is getting results that surprise even the most unsurprisable of our technical wizards.

The volume of 100-octane gasoline we are already making, and the tremendous quantities that we are planning to make to meet astronomical demands, are so much greater than anything we were asked for in the beginning, or thought we could possibly make, that history may very well rank this as the industry's outstanding war achievement. Actual quantities are the deepest military secret and some of the new products that have been developed as high-powered blending agents may not even be mentioned by name, let alone described. As just one example of the unbelievable expansion, one single oil company is now producing more 100-octane gasoline than was produced by the entire industry when the program started.

America's own billion-dollar rubber plantation, that is planting steel-jacketed rubber trees to produce more than a million tons of synthetic rubber annually when it gets underway, is based in large part on petroleum raw materials—butadiene, styrene, isobutylene. These man-made rubber materials already far surpass natural rubber in many properties. With war-accelerated expe-

Bomber shown in flight over field where many of her sister ships await completion. The supply of petroleum to the armed forces to keep these planes in the air; to keep all military demands satisfied is the first concern of the petroleum industry.



rimentation on so huge a scale, it is almost a foregone conclusion, some of our leading scientists report, that before long we shall be able to make, economically, synthetic tires that will outlast the car. Perhaps natural rubber will never again be used in large volume in this country.

Not only is petroleum providing vast quantities of toluene for TNT explosives—70 percent of the total at the last report, but undoubtedly much more now—but petroleum and natural gas are a fertile source of many other explosive raw materials. Hundreds of other regular and special petroleum products are accompanying our armed forces around the world; lice-killers, rust preventives, special greases and lubricants, for example.

On the home front, the accomplishments of the industry in this first year have been numerous, but they have been attended with manifold problems that have tried and strained the industry, physically and economically. We have been expected to operate the industry's physical facilities and to vary its production of different products with the agility and dexterity of a magician, while our economic existence has been laced into a straight-jacket in which Houdini himself could scarcely have moved, and from which he certainly could not have escaped.

Men, materials, and money are the basic problems responsible for the industry's growing difficulties. The manpower problem is becoming more critical every day, particularly in drilling and production and in refining, where many of the highly-technical jobs need men with years of training. Our War Council has discussed the problem fully, made several recommendations to Petroleum Administrator, and recently appointed a committee to confer with Administrator Ickes and War Manpower Chairman, McNutt.

Material shortages have plagued the industry for more than a year. Obviously, with military equipment and every other war industry and the burgeoning construction program all clamoring for the limited production of steel and other materials, the oil industry can expect to get only what it actually needs to do the job expected of it. Our problems have come because of what in some instances we have felt were failures to understand even these minimum needs.

Even without materials we have accomplished more than we ourselves thought possible. War Production Board, at the constant urging of the Petroleum Administrator and the industry, finally approved the steel and equipment for the "big inch" pipe line from Texas to the East. But that is only one part of the industry's far-reaching pipe line program to supply the oil-famished east. Even now the Petroleum Administrator is asking for material to build another big pipe line to the eastern seaboard. The gasoline pipe lines that ran from the Atlantic inland have been reversed, and are now carrying crude oil and refined products east.

American tank being hoisted aboard cargo vessel, preparatory to shipment to a battlefront. Official OWI photograph.

The record of the oil industry and of the Petroleum Administrator's office in the East Coast shortages is abundantly clear. For more than a year we have warned of the seriousness of the situation. Virtually every drop of oil consumed there—more than 60,000,000 gallons a day in normal times—must be brought more than 1,500 miles. Even before last November the shortage of transportation was serious. Now that the East Coast has become synonymous with the African front, it has progressed from serious to critical. The East Coast is now the front porch of Africa and Europe. Petroleum stocks there are nearly halfway to our armies, and obviously the Army and Navy have been forced to pick up supplies there rather than to send hard-pressed tankships all the way to the Gulf.

We have reached the point where we cannot forecast how much heating oil East Coast homeowners will get. We have not given up our efforts to increase deliveries by tank car even beyond the unprecedented amounts that they are already bringing in, and we hope and expect that everyone who really cannot convert to coal, but must heat with oil, will get three-fourths of what he used last year. Gasoline rationing, with its drastic curtailment in demand, has brought what is perhaps the industry's greatest present problem. Our refineries must reduce their production of gasoline to about the yield levels of 15 years ago, while at the same time the demand for war products and fuel oil rises steadily.

The operational problem itself is tremendously difficult. The modern refinery is flexible, it is true, but not in every direction at once. The manufacture of many of the most essential petroleum war products requires a large production of gasoline, hence the hundreds of refineries making these products must be given first chance to sell their gasoline in this curtailed market.

Somehow our technologists are solving the operating problems, but they are doing it in the face of severe strains that threaten the whole economic structure of the refining branch of the industry. Our costs are rising, and our returns are getting smaller as we are forced to sell less of our higher-priced and more of our lower-priced products. The impact of the war has brought these and other inevitable sacrifices. In the interests of the greatest possible efficiencies of operation, we long ago began to eliminate cross-hauls and other inefficient movements. We have borrowed and exchanged freely, both our products and our materials. Now we have begun to pool our terminals along the East Coast, and every branch of the industry is engaged in an exhaustive study of the possibilities, in efficiency and reduced manpower, of further pooling.

Together, the industry and the Petroleum Administrator for War have become a single mighty fighting force, one of the most unique and effective industry-government combines in Washington. Whatever the war demands in individual sacrifices we gladly and freely give, confident that when victory is won we shall have the earnest support of the Petroleum Administrator in picking up the pieces and putting the industry back together again.

OIL SUPPLY IS WEAKEST

While Nazis Hold Possession of Virtually All European Oil Production Supply is Inadequate for Heavy War Needs and Destruction of Petroleum Facilities Would Cripple Their Fighting Power.

GEOPOLITICS has long been the favorite study of a considerable group of German savants and in the Nazi scheme of empire it has held a leading place. The idea of solidifying political domination by extending it to cover specific areas capable of providing elements of self sufficiency which they have lacked in the past is one that appeals to their methodical habits of thought and writings on this subject in the past two decades abound in discussion of the location, extent and accessibility of these desirable elements. The belief that possession of certain materials basic to industrial strength would insure a German controlled European hegemony undoubtedly has governed the state policy of the Nazi regime as it has progressed from one goal to another during the past ten years.

Coal, iron, food and oil—these were the foundations on which German supremacy was to be built, enforced of course by an army so powerful and well equipped as to be able to prevail over any force that could be brought against it. Failure to command these resources in sufficient volume were cited as the reason for failure in World War I. The memoirs of General Ludendorff which dealt frankly with various causes of German defeat in that struggle dwelt at some length upon this subject. A few passages may be noted:

"Besides coal, iron and steel, the material for submarines, lorries and aircraft, and lubricants created some of our gravest problems. For lubricants we had to rely upon Austria-Hungary and Rumania. As the former country could not supply enough oil, and every effort for increasing her output of lubricants failed, the Rumanian oil was of decisive importance. But even when we had this source, the question of rolling stock remained very serious and impeded both carrying on of the war and life at home. In 1918 the stocks in the Caucasus promised better times. In our economic condition then, our home production of benzol was not suitable for submarines and aircraft. When, toward the end of the war, we did decide to supply benzol for our aircraft this was done solely on account of the shortage of petrol and in the face of the certainty that we were thereby reducing the fighting capacity of our aircraft and increasing the dangers to which

LINK IN AXIS ARMOR

Map suggested by Gabriel Dichter

View of the oil field at Nienhagen one of the oldest and most important fields in Germany.

they were exposed. Both stocks and consumption required constant supervision. The employment of automobiles had to be limited, more than ever, and even that of motor-lorries in quiet periods, in order to be able to make full use of them at critical times. I could not claim any better supplies for the army.

"The shortage of oil at home was serious. They did not obtain sufficient for the winter. The peasants had to pass the long winter evenings in the dark, which was very bad for their spirits. It is characteristic of Germany that little was ever said about this great inconvenience. For a time some of our transport difficulties were due to the bad lubricants used on the locomotives, which froze very easily. Private automobiles were practically not used at all in Germany. The whole rolling stock situation was one of the greatest anxiety and called for incessant watching.

" . . . The stocks that we found in Rumania were not large. The boring plant had been absolutely destroyed and the wells very cleverly blocked up. The English Colonel Thomsen had fulfilled admirably his duty of making it difficult for us to exploit the oil fields. His work was not, it is true, of decisive assistance to the entente, but it did materially reduce the supplies of our army and home. We must attribute our shortage in part to him. The military administration brought in men acquainted with the Rumanian oil industry and applied itself energetically to its second most important task, the restoration of the oil output, both by repairing blocked wells and by new borings, and by the re-establishment and resumption of working at the refineries. The output increased, although very slowly."

In the attempt to avoid previous mistakes and eliminate earlier shortcomings Hitler proceeded by carefully prepared steps to attain one goal after another. Abundant supplies of coal and iron were acquired first by his unopposed occupation of the Ruhr and later by the invasion of Luxembourg, Belgium and France. Food had to be sought in another direction. It could not be had from the thickly populated countries of Western Europe, incapable of supporting their own residents without imports. The geopolitic experts were ready with the answer. It pointed unmistakably to the broad, fertile and sparsely occupied regions of Western Russia, the Ukraine and its adjoining areas. Oil too lay in the same direction, but a long step further, in the Caucasus and beyond in the Near and Middle East. That the conquest of all this vast territory was charted in the Nazi book of plans before ever the first blow was struck against Germany's near neighbors is not doubted by those who have studied pre-war publications of Nazi geopolitical writers and the course of events in the ensuing years.

It was not to be expected of course, even by the most confirmed of Nazi adherents, that these distant goals could be reached without a protracted struggle. In order to find the means of carrying on the conflict until they could be won a careful survey was made of supplies attainable nearer at hand. In the matter of oil the survey was complete and accurate and the plans for its acquisition were executed with such rapidity, that by the end of the first year of war the Axis had come into possession of virtually all the oil resources of Europe outside of Russia. An unavoidable drawback was that these combined resources were inadequate to Axis needs in order to acquire the additional supplies that would make them immune to successful attack.

A glance at the accompanying map will show that there are two main centres of oil production in Europe, leaving Russia out of consideration. One of these is in Germany itself and the countries which before the war immediately surrounded it, now all under complete Nazi domination. These countries—Poland, France, Austria, Hungary, and Czechoslovakia—as well as Germany itself, were possessed of relatively small oil fields. Their aggregate production, including also that of Italy and Italian controlled Albania, in the last year preceding the war was 1,370,000 tons, less than 10,000,000 bbl., hardly equal to a week's outturn by the State of Texas under the rigorous restrictions of proration.

Below: The waterfront of the River Save at Belgrade.

A second, and more important, producing territory is that of Rumania, in the heart of the Balkans, 800 miles southeast of Germany. Rumania, before the war, was producing 6,600,000 tons of oil yearly and was the only European country having a substantial surplus for export. In the first World War, as pointed out by General Ludendorff, the Germans overran Rumania only to find that its wells had been effectively put out of commission. Efforts to restore production met with no substantial success. Determined to avoid a second experience of this sort the Nazis moved into Rumania in force in September 1940, took possession of the country and posted their troops throughout the oil fields. Thus they took over the wells and refineries in good working order before measures of sabotage could be applied. They also acquired rather large stocks of oil held in storage which had been purchased by British interests for the express purpose of keeping them out of German hands.

Being thus in possession of all the natural oil production of Europe except that far removed in Russia the Axis was still short of the supplies needed for carrying on a war of continental dimensions. The total output of all the fields immediately preceding the war was approximately as follows:

Country	*Metric Tons*
Rumaina	6,600,000
Poland	525,000
Germany, Old Reich	550,000
Germany, Austria	60,000
Germany, Czechoslovakia	20,000
France	70,000
Italy	15,000
Italy, Albania	65,000
Hungary	40,000
Total	7,945,000

All the oil produced in a year by all Europe except the Soviet Union was less than 8,000,000 tons, less than 10 percent of Europe's own peacetime requirements, less than a normal three weeks production by the United States. In passing it may be mentioned that the output at the present time probably is no greater, is perhaps about 7,500,000 tons. Extension of the Hungarian fields is said to have raised production there to between 300,000 and 400,000 tons. The Italians claim that the Albanian output has been enlarged to 200,000 tons though it is doubtful if Italy is able to transport and put to use that quantity now. New drilling in Germany proper is alleged by the Nazis to have given its fields an annual outturn of over 1,000,000 tons though those conversant with conditions are inclined to estimate it more conservatively at 600,000. On the other hand Rumanian yields which were declining even before the war are reported to have fallen to 5,500,000 tons or less so that the decrease here offsets the gains further west.

Earlier estimates by German statisticians placed probable wartime requirements of that country at a minimum of 12,500,000 tons a year with some authorities expressing the view that 20,000,000 tons would be needed. These estimates all were based upon military operations similar in scope to those of 1914-18 and did not envisage the maintenance of a 2000-mile front in Russia together with the occupation of nearly all the remainder of the European continent. Even at the lowest estimate possession of all European production that the Axis could hope to acquire quickly was insufficient to carry on a war conducted in the manner of today, a war of machines.

This too had been foreseen by the Nazi strategists and they had set about filling the gap by the only available means, the production of synthetic oil mostly from coal but partly by other methods. By 1939 Germany's synthetic production had reached 1,800,000 tons and new plants under way or projected were expected to raise the output to 4,000,000 tons or more by 1942. Whether that figure has been reached or not nobody outside of German military circles has exact information but there is reason for believing that this production is still not much above 3,000,000 tons which would leave a rather serious shortage. Nevertheless the Axis has gained a decided advantage from its possession of these European fields for fueling the movements of its armed forces in both the eastern and western theatres of operation. This is evident if a vertical line is laid from south to north through Vienna and two large circles are drawn surrounding the two main producing areas and taking in the greater part of the areas covered by the war. In the east Rumania is well situated to supply the Russian front, the Balkan front and through Italy the front in Africa. It is advantageously placed to provide supplies for a thrust toward the Middle East. In the west German controlled production plus synthetic oil lies within convenient reach of the war industries concentrated in that area, the submarine bases and the air fields strung along the coast from Norway to Southern France.

It is curious to note that the radii of these two circles are almost equal and furthermore—a feature that no doubt appealed to the geometrical minds of the German geopoliticians—that nature has joined the two centers of production by Europe's largest waterway—the Danube—which is almost equal to their combined length. The advantages that have been reaped from this setup by Germany in supplying her war industries and her maritime and aeronautical bases are obvious. In the western sector products are easily distributed with no great expenditure of time and transport. The same thing applies to Rumanian products in the east although here transportation facilities are much inferior. Owing to the difference in volume of production in the two areas, supplies have to be brought from Rumania to supplement production in the western district and special efforts have been made to improve transportation facilities on the Danube in order to expand that movement.

German fuel tanks found strewn through the town of Pogoreloye-Gorodishsche in Russia after the Nazis were driven out.

Aside from the statements of German strategists, economists and geopoliticians that Rumania was one of the necessary fulcrums to German domination over Europe there is abundant evidence that the seizure of that country was carefully planned in advance to the extent of definite specifications for increasing transport capacity by putting down new railway trackage, building pipe lines and improving the Danube waterway, the objective being to provide for the movement of 3,000,000 tons of oil products yearly over this route. German infiltration of the oil industry

Oil for Hitler's war machine. Tank cars being loaded for shipment to Germany.

and efforts to obtain financial control of Rumanian oil companies began long before the arrival of Nazi legions. The location and description of wells, refineries and storage depots were minutely recorded. Influence was brought to bear to shape petroleum legislation and administration to serve German interests. Preparations went even to the length of printing special marks with which to purchase oil shares and properties in order to give an appearance of legality to the assumption of control.

That the Axis has not been able to make all the progress in its eastward drive that its leaders had expected to attain with the aid of Rumanian oil is not due to errors in planning but to the heroic resistance which its armies have encountered. The fact remains that this oil supply is vital to the maintenance of its fighting ability and in this respect is equal in importance to the production that centers in Germany proper. Since it is true today that no nation can conduct an offensive or even defend itself without a huge consumption of oil by its land, sea and air armaments it follows that the areas within the two circles marked on the accompanying map are military objectives of the first order. Whenever the United Nations are in a position to undertake a systematic and continuous assault upon these sources of petroleum supply they will be able to paralyze the Axis military power to such a degree that its collapse and destruction will follow. This attack must come primarily from the air. While the bombing of oil fields is not particularly effective refineries, tank farms and storage depots are highly vulnerable to aerial attack. This is especially true of a country like Rumania where the great bulk of the crude output is processed in refineries in centralized locations. A few bombing forays over the Ploesti area were made by the Russians in the early period of their fight against the Axis and on one occasion American planes made a flight over Rumania but these probably resulted in no very serious damage.

To stop the flow of oil supplies to Axis forces steady and persistent bombing will be required on a scale sufficiently large to cover refineries, storage stations, railway junctions, tank wagon trains and, if possible, steamships and barges traveling up the Danube. Granted that the United Nations do not yet have sufficient planes to spare from the zones of active combat and do not possess strategic bases from which sustained attacks can be launched the rising tide of their strength and the progress of their movement to encircle the Axis will provide these essentials if the purpose is kept steadily in view.

Such a sustained assault would be capable not only of crippling the Axis oil supply at its most vulnerable point but also of discouraging or greatly diminishing Rumanian miltary support of the Axis cause. More than 1,000,000 Rumanians have died in the fiercest fighting on the Russian front; the population is starving despite the agricultural wealth of the country; Rumania has lost her independence and a large part of her territory; she has lost her friends and through the Iron Guard her ablest statesmen have been wantonly killed. Finally, as illustrating the Nazi sense of humor, Rumania pays a daily monetary contribution for German military assistance. There cannot be a more illuminating picture of the working of the new order in Europe. Nor can there be any doubt that the fires of hatred lighted by this treatment will be fanned into active resistance whenever the chance of making this effective presents itself.

The same considerations supporting a large-scale attack on Rumanian oil facilities apply to the means of petroleum supply lying within the western circle. Here the task of destruction is made somewhat more difficult by the fact that synthetic plants, storage centres and refineries are more widely dispersed. On the other hand the objectives are within bombing range of established British bases and the mounting scale of the raids from these bases already has taken a heavy toll of German industrial plants and communications facilities including refineries and oil storage. Once the assault can be driven home from both directions in sufficient force to destroy or incapacitate the larger part of the Axis supplies of liquid fuel the menace of its planes and submarines and armored troops will end and its power of resistance will cease to be formidable.

Remembering that this is a war of oil, that lack of oil means inevitable defeat and that the Axis in Europe at least, already is handicapped by insufficient oil supplies it appears an obvious part of United Nations strategy to concentrate a heavy attack at the earliest possible moment on this the weakest link in their opponent's armor.

Below: A railway siding in Campina, especially constructed for loading oil tank cars.

WAR NEEDS WILL GOVERN

OIL ACTIVITIES IN 1943

Decline of 23 Percent in Net Income During 1942 Reflects Influence of Rationing and Operating Changes Imposed by Military Needs—Government Control Seen as Dominating Factor in 1943.

MANY PROBLEMS confront the American petroleum industry in the new year. They stem from the war economy and affect all divisions from exploration and development of crude oil production through transportation, refining and marketing of the finished products.

Some of these problems were factors in operations during the year just closed. For all practical purposes, the industry is under full governmental control. This control, however, is not working smoothly; at least it hasn't up to date. It has been a multi-control where one agency orders the accomplishment of a certain objective but lacks authority to provide compensation for it. Meanwhile, the agency which has power over prices, or payment, fails to take action.

Perhaps the most glaring example of this inconsistency is in the matter of ordering the industry to adjust its refinery operations to produce 20 percent more fuel oil, a secondary, less profitable product, and reduce the yield of gasoline, the major money crop. It is tantamount to asking private industry to subsidize the federal government. Basically the change means that the refining industry east of the Rockies; embracing about 80 percent of the country's oil refinery capacity; produce more fuel oil which sells at wholesale in the important Gulf Coast markets at from 2.00 to 3.75 cents a gallon to the detriment of gasoline which sells for 5.5 to 6.25 cents a gallon.

The transition to a fuel oil economy, from the normal gasoline production, is costing the industry hundreds of thousands of dollars every day east of the Rockies alone. As yet no conclusive action has been taken to provide compensation for the changeover although the subject has been under discussion with the Petroleum Administrator for War (formerly the Office of Petroleum Coordinator) and the Office of Price Administration. Moreover, this situation will become more serious in the new year, with a consequent bearing upon profits. The accelerating tempo of war activity will require larger production of aviation gasoline, fuel oil and petroleum coke, as well as specialized war products such as butadiene, base for synthetic rubber, and toluol, principal ingredient of tri-nitrotoluol.

Meanwhile gasoline, the industry's major product for many years, is rapidly fading into a secondary rating as the result of rationing to conserve rubber, and because of transportation problems. The expectation is that some means of compensation will be developed to provide for the changeover. This is based on the recent appointment by President Roosevelt of Harold L. Ickes, formerly Petroleum Coordinator for War with powers largely advisory, to become Petroleum Administrator for War with additional, but still limited, authority over oil industry operations. With his new title, Mr. Ickes has been placed on a par with the Office of Price Administration and with the War Production Board. His recommendations, hence, are expected to carry more weight. Furthermore, the President's directive orders the O.P.A. and the W.P.B. to consult and advise with Mr. Ickes on problems concerning the industry.

Bound for distant allied ports, twin-engine bombers being hoisted aboard ship in an American port from a lighter alongside. Expert welders fasten the big planes securely to the ship's deck to protect shipments from damage during heavy weather. Official OWI photograph.

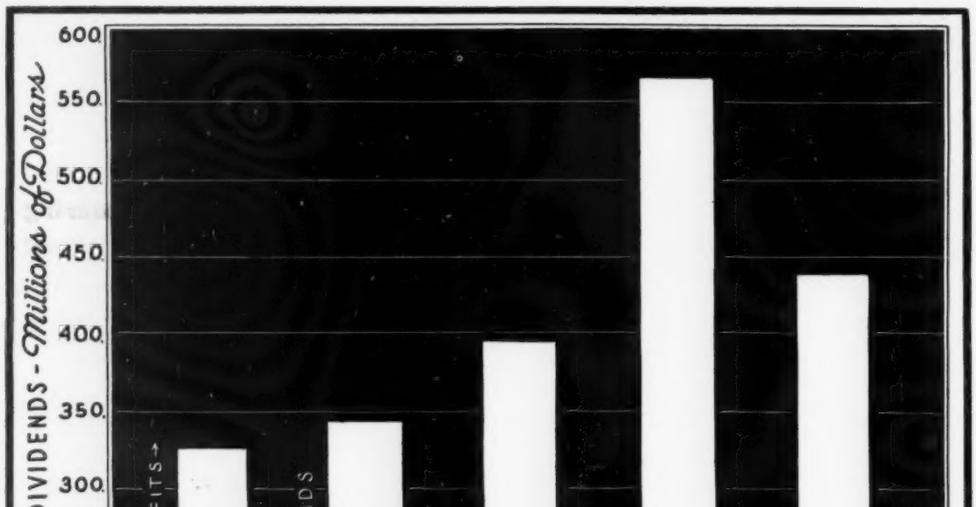


Chart showing net profits and dividends of 23 leading oil companies in the United States.

Prior to the recent enlargement of Mr. Ickes' authority, the suggestion had been made that probably some form of subsidy, similar to that which obtains for excess transportation costs overland as against normal tanker deliveries to the eastern seaboard, would be worked out. This hasn't materialized as yet, however and the industry would prefer the normal method of higher prices. In any event, the changeover in refinery operations is a major problem for the industry today. Its importance was stressed by the Petroleum Industry War Council recently in these words:

"The main deterrent to the accomplishment of yield changes to date has been the fact that present price ceilings were set at a time when much more gasoline was needed. These ceilings discourage the production of additional fuel oil and fail to compensate the refiner who complies with the basic needs of the present situation.

"Even if arrangements were already guaranteed whereby the necessary adjustments would be made to maintain the industry in a sufficiently solvent condition to meet the altered yield requirements, there still exists the question as to how the compensation would be granted.

"O.P.A. and O.P.C. have relied heavily on the patriotism of the industry and its executives to meet the wartime needs regardless of profits or losses, but in the long run a patriotic corporation can no more run on losses than a patriotic automobile can run on water."

The production division of the industry, too, is not without its problems. Here the principal deterrent is price, as well as materials and equipment to continue development in order to maintain a sufficient crude oil reserve position. Because of governmental restrictions on drilling, and ceiling prices on crude oil, the country's reserves are being depleted at a rate substantially greater than discoveries of new reserves.

These, too, have been brought to the attention of governmental authorities but without leading to definite action. During 1942, as an instance, well drilling was reduced by approximately 40 per cent and discoveries of new reserves, aside from revisions in existing reserves, fell below withdrawals. For 1943 the pattern is further restricted because of non-availability of critical materials. Indications from the Petroleum Administrator for War are that probably as much as 20 per cent more curtailment will be imposed as against 1942. As last year, the current year's drilling activity will be well below normal.

In this regard the governmental agencies have failed to recognize the change in conditions—higher cost for labor and materials and increased taxes. The Office of Price Administration has constantly refused to grant a price increase, one of the chief incentives to a continuance of exploration for new reserves. The Petroleum Industry War Council also went on record with the statement that "present crude oil prices do not provide sufficient funds or the incentive for needed exploratory work," and added:

"It is essential to the proper protection of our country that the necessary incentives be made available to stimulate increased exploratory effort. This requires the necessary materials and supplies and a compensatory price for crude oil."

While petroleum geologists have expressed the opinion that the present rate of withdrawals of crude oil may be continued for some time, any substantial increase might have to be accomplished with considerable waste, unless new fields are discovered. Production from present known reserves in the eastern and mid-continent areas, and in California, cannot be increased much if any, above existing levels. There can be some increase in the rate of production, without waste, from known reserves in Wyoming, New Mexico, Louisiana, West and Southwest Texas, and the Texas gulf coastal area. The total increase possible, however, without waste in these areas may be insufficient to supply the expected increased war demand for petroleum for this country and the other United Nations because production in other areas is declining.

These problems, together with an extension of gasoline rationing to embrace the entire country, were chiefly responsible for lower earnings for the industry, as a whole, during 1942. Solely producing companies, with no refinery problems, fared much better than the integrated companies. They were aided, in some instances, by curtailed expenditures for drilling in line with restrictions imposed by the government, and production held fairly well with 1941. Several producing companies, in fact, had a slight increase in profits last year.

The trend of earnings in 1942, moreover, was steadily lower as the year progressed in line with the accumulation of such factors as increased costs for labor and materials, and higher taxes.

For 23 leading companies in the first nine months of 1942 net profits aggregated $128.5 million against $165.9 million in the corresponding period of 1941, a reduction of 23 percent. Producing companies such as Plymouth, Barnsdall (excluding a non-recurring profit in 1941), Ohio (it has a relatively small refining and marketing business), and Amerada, were ahead of 1941 in earnings.

Atlantic Refining Co., fully integrated, but with its operations pretty much concentrated on the Atlantic seaboard, was one of the hardest hit because of the difficulties of transportation to the eastern seaboard, and also in line with rationing which has prevailed there since May, 1942. Its net profits were equal to only 40 cents a share in the first nine months of 1942 against $3.27 in the similar period of 1941.

Table I: Net & Per Share Profits for Nine Months 1942-1941

	1942		1941	
	Net Income	A Share On Com.	Net Income	A Share On Com.
Shell Union	$11,769,643	$ .90	$14,485,986	$1.10
Atlantic Refining	1,522,000	.40	9,163,045	3.27
Barnsdall Oil	1,952,960	.88	*4,453,985	1.97
Lion Oil Refining	655,200	1.51	745,063	1.71
Phillips Petroleum	10,481,332	2.36	12,562,598	2.82
Plymouth Oil	1,239,034	1.20	1,015,924	.98
Standard (California)	21,455,073	1.65	24,613,198	1.89
Amerada Petroleum	1,971,169	2.50	1,817,911	2.30
Houston Oil	906,532	2.53	885,571	2.47
Texas Pacific Coal & Oil	616,976	.69	770,131	.87
Seaboard Oil	883,766	.68	878,023	.71
Mid-Continent Petroleum	4,794,060	2.58	3,553,398	1.91
Quaker State	1,014,782	1.09	1,508,454	1.63
Texas Co.	26,458,117	2.43	40,063,434	3.68
Tide Water	7,466,445	.90	9,790,595	1.27
Union Oil	4,474,265	.96	5,087,577	1.09
Skelly	3,927,202	4.00	4,027,895	4.10
Ohio Oil	9,244,080	1.28	7,804,288	1.02
Continental	9,249,606	1.97	8,590,802	1.83
Standard (Ohio)	3,413,360	3.92	4,464,096	5.31
Richfield Oil	2,045,854	.51	3,365,088	.84
Pan-American P. & Tr.	2,536,816	.54	5,702,896	1.21
Darby Petroleum	511,814	1.46	562,953	1.60
Totals	$128,592,086		$165,912,931	23%

(*) Includes a non-recurring profit equal to $1.12 a share.

Table II: Net & Per Share Profits for Six Months 1942-1941

	1942		1941	
	Net Income	A Share On Com.	Net Income	A Share On Com.
Standard (Indiana)	$19,390,526	$1.27	$21,763,134	$1.43
Pure Oil Co.	6,782,000	1.21	4,900,000	.74
Standard (New Jersey)	43,000,000	1.58	74,000,000	2.71
Consolidated	8,423,448	.65	3,471,941	.26
South Penn Oil	1,853,723	1.85	1,203,197	1.20
Socony-Vacuum	13,500,000	.43	13,000,000	.42
Creole Petroleum	2,200,000	.32	4,895,000	.70
Totals	$95,149,699		$123,233,272	23%

In Table I are shown 23 leading companies with their net profits and per-share earnings on common stock for the first nine months of 1942 compared with the corresponding period in 1941.

Seven companies report only on a semi-annual basis and their profits in the 1942 first half of $95.1 million compared with $123.2 million in the same 1941 period, a reduction also of 23 percent. These are shown in Table II.

The operating prospect for the current year is less encouraging than in 1942, unless some of the problems confronting the industry, and mentioned earlier in this article, are resolved. Besides the companies are faced with an extension of rationing of gasoline, normally a main source of profits, whereas for most of 1942 only the eastern area was experiencing such rationing. Incident to rationing, costs of operation will be relatively high on a smaller volume of business.

In spite of a reduction of 23 percent in profits for the first nine months of 1942 for the industry as a whole, dividend payments to common shareholders (in cash) showed only a reduction of 14 percent for the full year as against the previous year. For 23 leading American companies used in WORLD PETROLEUM's tabulation, dividend payments in 1942 aggregated $219.3 million to common stockholders against $255.5 million in 1941.

Nine of the 23 companies paid smaller dividends last year than in 1941. These included Standard Oil (N. J.) which disbursed a total of $2 a share against $2.50 in 1941; Atlantic Refining Co. 70 cents against $2; Gulf Oil Corp. $1 against $1.50; Phillips Petroleum $2 against $2.25; Skelly Oil $1.25 against $1.50; Standard of Indiana $1.25 against $1.50; Texas Co. $2 against $2.50; Tide Water Associated 70 cents against $1; Standard Oil (Ohio) $2.25 against $2.50. One company, Mid-Continent Petroleum Corp., in line with an improved profit showing, paid larger dividends last year ($1.40 a share) against 1941 when it disbursed an aggregate of $1.15 a share. While the net results of oil industry operations during 1942 have been less satisfactory than those of the years immediately preceding they have been surprisingly good considering the handicaps under which the industry has been operating. In part this has been due to the fact that the impact of the war did not seriously affect the business of many companies until about the middle of the year or later. In 1943 the industry faces problems even more difficult in many respects than those it has had to deal with in the past twelve months. It has become a full fledged war industry and its activities, being concentrated more and more upon support of the military operations of the United Nations, are increasingly under the control and direction of governmental agencies. The manner in which this control is exercised will have most to do with final results in the coming year.

Tank cars shown here at loading rack, have done a remarkably fine job in the transportation of oil to the East.

OIL FRONT ASSUMES GROWING IMPORTANCE

As War Activities Increase

By Ralph K. Davies

Deputy Petroleum Administrator for War

Enlarged Authority Conferred on Petroleum Administrator Should Facilitate Handling of Available Materials, Supplies and Products—Main Industry Problems

Ralph K. Davies.

As the nation goes into its second year of war, the Petroleum Administration and the oil industry can take satisfaction in the fact that, working together as partners, they have succeeded thus far in fulfilling the petroleum war assignment. Had there been failure in any important respect, the military successes of recent months would not have been possible and, on the home front, instead of an admittedly critical supply situation we would be faced today with a disastrous shortage of essential fuel.

The fighter pilot winging over Guadalcanal or the landing party at Algiers might, at first glance, appear to bear no relation to the alteration in refining yields at a Philadelphia refinery or the trainload scheduling of tank cars between Chicago and New York. But an army is dependent upon its supplies, and we who have a part to play in making petroleum available when and where it is needed are contributing in a very real way to the heartening exploits of our heroes in the far corners of the earth. We cannot, however, allow ourselves to be lulled into any false sense of security. The military successes thus far achieved have but increased the load on our national economy, necessitating a speed-up all along the line. There can be no relaxation of war measures now. The requirement for petroleum products for military use is steadily increasing as the fighting spreads and, at the same time, we are being forced to get along with a diminishing supply of materials, transportation and manpower. From here on out we must contrive continually to do more with less.

As the oil problem has increased in importance and in complexity, the President has acted to centralize war policies and actions of the Government relating to petroleum through the issuance of an executive order esctablishing a Petroleum Administration for War. The new agency, responsible directly to the President, supplants the Office of Petroleum Coordinator for War, and has received a broad delegation of war authority which will greatly facilitate the governmental direction of oil activities during the critical period ahead. By clarifying our relationships with other Washington agencies the new order puts an end to much of the confusion that has heretofore existed, and by extending authority commensurate with our responsibilities, it enables us to deal more directly and forcefully with the problems of oil.

In addition to centralizing in the Administrator all of the federal functions dealing directly with oil in this time of war, the order empowers the Administrator to exercise, by way of statutory orders issued in his own name, all of the authority and discretion conferred upon the President by the priority and allocation provisions of the Second War Powers Act. Although oil men have generally thought of priorities and allocations as applicable only to materials received by the oil industry, it must be remembered that petroleum itself is a critical material, essential for waging war and maintaining all industry, and as such just as much susceptible of regulation and allocation for the purpose of assuring and stockpiling necessary supplies as any other commodity. The delegation of statutory powers to the Administrator is therefore sufficiently broad to encompass whatever regulation may be necessary with respect to the quantity, quality and time of delivering crude oil or its products from any wells, fields, refineries, or terminals. The same is true with respect to the delivery of natural gas from oil or gas fields, since gas, by this executive order, is included in the definition of petroleum.

While there has been a change in organization and in name, the same fundamental policy of cooperation continues to guide this office's relationship with the industry. From its inception in the summer of 1941, the OPC sought to enlist the industry, as partners with government, in the task of coordination. A committee organization was developed on a comprehensive geographical and functional basis which, together with the Petroleum Industry War Council as the central national body, and the Foreign Operations Committee representing the foreign field, gives us something that so far as I know is unique in war administration. We have organized to take full advantage of the talent and experience of the oil men of the nation. The Petroleum Administration for War has no intention of altering the cooperative relationship that has proved so successful in the past. It recognizes that, in the final analysis, it is the petroleum industry that must

get the oil job done. The executive order of December 2 gives us in Washington the necessary implementation to direct effectively the operations of the petroleum industry and, by virtue of that fact, the industry organization is enabled to play an increasingly important part in the solution of the many problems which we will be called upon to face together.

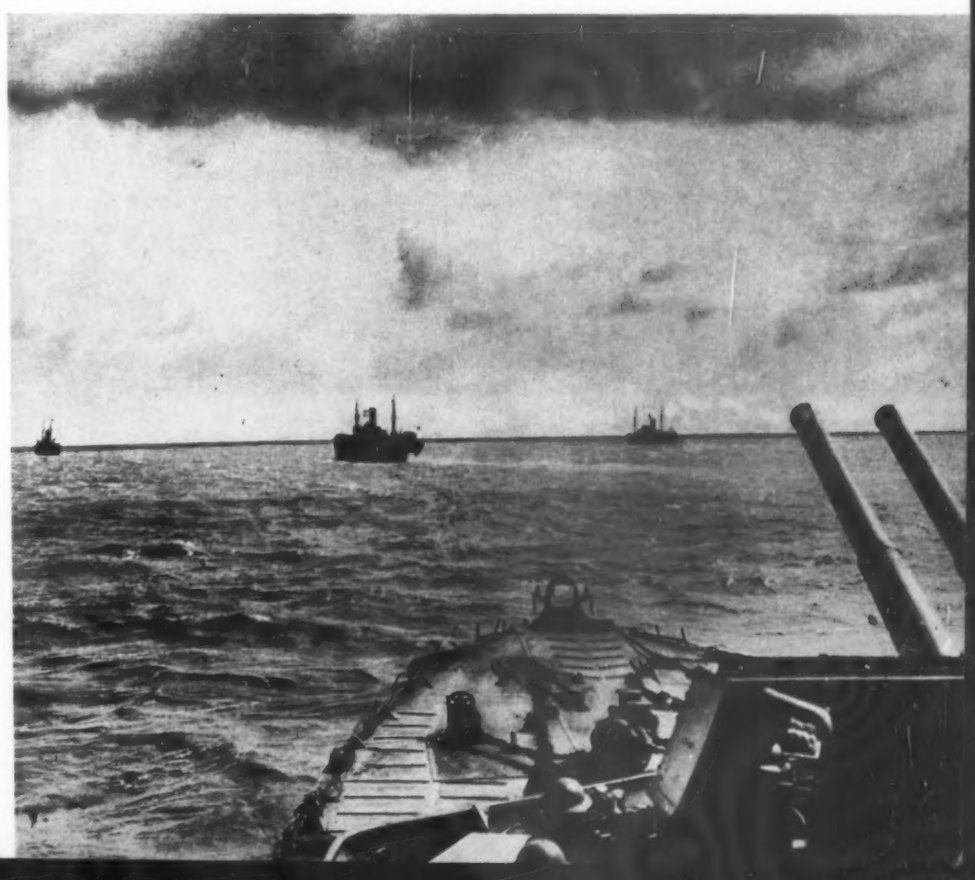
Looking back upon the year past, this office, in collaboration with the forces of the industry, has had to deal with a wide variety of problems. Only a few can be mentioned briefly here. One of the most critical issues, which has been of great concern ever since the creation of the office, is the matter of oil supply for the East Coast. We foresaw the drastic dislocation in normal tanker transportation that would occur as more and more tankers were withdrawn for military service and took steps to augment the alternative movement of oil to the areas normally served by tank ships. After careful analysis by appropriate groups of the industry, a comprehensive program was launched. The results thus far have exceeded the most sanguine hopes of a year ago. The oil men and the transportation companies have done a breath-taking job in building up the overland movement of oil by tank cars, pipelines, and barges—an accomplishment based on careful planning, unswerving determination, and the exercise of great ingenuity. The War Emergency Pipeline, completed as far as Illinois, is now being extended on to the East Coast. In addition, we are urging that materials be made available for a second large pipeline from the producing areas of Texas to the Atlantic Seaboard, both to assure adequate petroleum supplies to meet the requirements of war industry in the East and to protect the availability of oil for trans-shipment by the shortest tanker routes to the United Kingdom and the fighting fronts.

While public recognition has been given to the transportation miracle that has been accomplished by the industry, it is not so generally known—except among oil men—that these profound readjustments in transportation have necessitated equally complex and far-reaching readjustments from the supply standpoint. Tank cars, pipelines, and barges would be of no use if oil were not available at the right times and places to be transported. The oil companies have been required, practically overnight, to revolutionize their normal methods of operation in order to assure the availability of crude and product for shipment to the Atlantic Seaboard through the emergency facilities that have been developed. Like a hungry vacuum, the East Coast area has sucked oil from the whole region east of the Rocky Mountains and there is not an oil company operating in that vast area that has been unaffected. I know of no more complex or difficult job than this one of rearranging petroleum supplies. It has required a wholesale shift in the supply relationships as between companies and, without the most careful planning and coordinated execution, the result would have been complete chaos. In no country except America, and in no industry except oil, in my opinion, could a cooperative undertaking of such gigantic proportions have been carried out successfully.

While much has been accomplished, much still remains to be done in building up the overland movement of oil to the shortage area. New demands are continually being placed upon us for large volumes of oil for essential consumption on the East Coast and for shipment to the military theaters, and the end is not yet in sight. The industry has demonstrated its ability to tackle a big job, but it cannot rest upon any past performance. It must apply itself to the further perfection of its transportation and supply programs until every barrel of product—of the particular kind needed — that can physically be produced and transported is actually moved to the required destination. On the oil front, this represents one of the most important continuing problems. Closely related to the foregoing is the problem of managing the available supplies on the East Coast, and in other shortage areas as well, so that the essential requirements of the war program will be met. Aside from the controls that can be placed in effect from Washington, it should be recognized that the industry must play an increasingly important part in exercising an intelligent control over its inventories. During the critical winter months stocks will be drawn down to the barest minimum and the companies will have to operate with much smaller inventories than in normal times. This will require the most careful kind of management to preserve necessary flexibility and to protect the availability of essential products. Here is an opportunity for the industry — and particularly for the non-integrated marketers and jobbers who have a large percentage of the available storage of fuel and heating oils—to make a valuable contribution. Through collaboration with other companies, and under the leadership of the industry committee organization, there must be a carefully coordinated and balanced handling of the inventories of essential products.

The East Coast supply problem requires not only readjustments in the transportation and distribution of supplies, but in refining operations as well. During the past year attention has been given to the matter of so altering the yields of products at refineries as to produce more of the fuel and heating oils that are so vitally needed for war industry and for home heating, and less gasoline. The demands for refined products under today's conditions—demands which are on the must list—so disrupt normal operation that it is clearly impossible to go along without scheduling from a central source the operating practice of each refinery. The natural balances that operate in a free economy are no longer possible, for obvious reasons. The Petroleum Administration has undertaken, therefore, the preparation of operating schedules to meet the emergency situation. This is a delicate, difficult, and vitally necessary work, and it is being done in close collaboration with the industry committees. Marvelous results have been achieved in the development of the program for increasing our supplies of 100 octane gasoline, toluene and rubber, and I know that the problem of balancing refinery yields can also be met if it is tackled by our combined forces in the same cooperative spirit. I submit that this is one of the most critical and important engagements on the oil front.

The various phases of oil industry operations are so interrelated that the changes that are required in one branch, such as distribution or refining, are reflected in adjustments in the other branches and are immediately affected by the dislocations that occur elsewhere, as well. It has been impossible, for example, to continue normal production



The protection and transportation of cargo to our battlefronts requires a tremendous amount of fuel, but the petroleum industry has accomplished the seemingly impossible.

operations in the Gulf Coast area with offshore tanker movements interrupted by the war, and heavier demands have been placed upon the producing fields of the Midwest which is closer to the Eastern Seaboard by the overland route. The increasing requirement for 100 octane gasoline, toluene, and fuel oil has necessitated a greater production of special grades of crude from which a larger volume of these particular products can be manufactured. In view of the irreplaceable character of our natural resources of oil and gas, we have naturally been concerned, on the one hand with stimulating the discovery of additional reserves and, on the other hand, with assuring that the most efficient possible use is made of the known reserves. Here, too, the industry has both a responsibility and an opportunity to do an important war job.

In every branch of the industry large volumes of materials are required to construct the new facilities that are needed, to drill necessary wells, and to maintain the existing plant in good working order. In accordance with the clear-cut intention of the President, as set forth in the new executive order centralizing all federal functions with respect to oil in the Petroleum Administration, the War Production Board has officially designated the Petroleum Administration as the Claimant Agency in the matter of materials to be supplied to the whole petroleum industry. This means that it will be the duty of the Administrator to claim on behalf of the industry the total amounts of materials which the Administrator estimates will be required to produce and ship those quantities of crude oil and its products indicated as necessary to supply future demands. Of course, it remains the function of the War Production Board to balance these claims against those submitted for other industries, but once a total allotment of materials has been made by that Board, under the executive order the Petroleum Administrator has the responsibility of distributing the resulting block of materials among the various branches and companies operating within the petroleum industry.

The allocation of supplies and equipment to the petroleum industry can only be made intelligently in the light of detailed facts as to requirements, and the supplies that are available from existing inventories, as well as through reclamation and re-use. To centralize the industry's activities in this relation, the Petroleum Administration has organized Materials Sub-committees of the General Committees in each district and has charged them with the responsibility of gathering the required statistical data and coordinating the varied activities, so far as they relate to materials, of the other industry groups that are concerned with planning the joint use of facilities, the salvage and reclamation of usable goods, and the availability of materials for maintenance and for new construction programs. This is but one more complex and far-reaching assignment that we have called upon the industry to undertake. During the coming year it will, I am sure, assume ever-larger proportions as the nation strips itself for action on many fighting fronts.

No less important than domestic wartime petroleum problems are those connected with foreign operations. It is the function of the Foreign Division of the Petroleum Administration to collaborate with appropriate federal departments and agencies in determining plans and policies with respect to foreign petroleum activities and, in conformity with such plans and policies, to direct the foreign operations of American petroleum companies. In very much the same way that the Petroleum Administration works in cooperation with the domestic petroleum industry, it carries on its activities in close collaboration with the foreign industry through a committee organization which is headed by the Foreign Operations Committee. Special committees have been created to cover various geographical areas and to consider special problems of importance as they arise. Close contact is maintained by this office with the United States representatives of the Allied Governments, such as the British petroleum representative, the Government Purchasing Commission of the Soviet Union in the U.S.A., and China Defense Supplies Incorporated. Through petroleum attaches in many United States embassies and legations throughout the world, and through local industry or "pool" committees, we are able to keep in close touch with the foreign governments which do not have petroleum missions in this country, so that their needs will be provided for equitably and as fully as the available resources permit. The full story of petroleum outside of the United States cannot now be told, but careful plans are being laid and highly complex and interrelated operations all over the world are being carried out by the American petroleum industry in collaboration with government, in a manner that, I think, will reflect credit upon all concerned, and will contribute in an important way to the ultimate victory.

PRODUCTION OUTLOOK FOR 1943

By D. R. Knowlton,

Director of Production
Petroleum Administrator for War

Petroleum Administrator's Program Looks to Drilling of 4,500 Wildcats and 11,500 Development Wells as a Minimum for Coming Year—Conservation of Materials Important

UNDER THE Executive Order issued by the President on December 2, 1942, the Petroleum Administrator for War was charged with the responsibility to " . . . establish basic policies and formulate plans and programs to assure for the prosecution of the war conservation and most effective development and utilization of petroleum in the United States and its territories and possessions. . . . Prepare and recommend to the War Production Board estimates of the quantities and kinds of material needed by the petroleum industry to produce. . . . (and) Effect the proper distribution of such amounts of materials as the Chairman of the War Production Board may allot for the use of the petroleum industry." Most of the problems of the Production Division of the Petroleum Administration for War during 1943, and in fact for the duration of the war, will involve one or the other of these responsibilities. Restated more precisely, these responsibilities are:

1. To provide adequate supplies of petroleum for military and other essential uses, and
2. To allocate materials for production and to see that all materials for production, whether new, in use, or reclaimed and reconditioned, shall be used most efficiently.

Fortunately the petroleum industry was able to meet all requirements for crude petroleum during the first year of the war. The consensus is that production demands will increase as the war progresses and can be met only under increasing difficulties. To be certain that requirements, even at present rates, can be met throughout the duration of the war, it will be necessary to find and maintain adequate developed underground reserves. The proved petroleum reserves of the United States amount to approximately 20 billion barrels. Erroneously, this reserve is too often interpreted to represent an adequate petroleum supply for 13 or 14 years based on the present rate of consumption. The fallacy in this reasoning lies in the failure to recognize that even the most efficient production rate cannot be sustained year after year. Instead, there is a diminishing return that is always expressed in a declining production rate. To produce all recoverable oil in the presently known reserves will require 30 to 50 years. The present rate of production or an increase to meet the augmented demands of war cannot be met for long unless additional reserves are discovered at a rate at least equal to the rate of consumption.

The greater part of the known petroleum in the world are situated outside the United States.

Donald R. Knowlton

Fortunately a large proportion of such reserves are still largely under control of the Allies and other friendly nations. Nevertheless, the production from many of the fields outside the United States has been rendered unavailable, in large measures for supplying the Allied war program at the present time, as a result of the shortage of tankers and the hazards of tanker transportation, the great distances between centers of refining and points of consumption, and through the lack of adequate refining capacity adjacent to the foreign fields. Furthermore, many of the more important foreign fields now in the possession of our allies are vulnerable to enemy attacks. Although these fields seem relatively safe at the moment, there is still a danger that they might fall into enemy hands. If this should happen, it would only serve to increase materially the burden placed on United States production. Regardless of this eventuality, it is essential that the United States maintain a backlog of available known reserves and adequate productive capacity sufficient to meet the greater part, if not all, of Allied demands for petroleum products for war purposes. It is certain that the United States will continue to be called upon to supply more than its proportionate share of petroleum products for the "duration." No one can anticipate the future demands with accuracy; it is generally agreed, however, that demands made upon the petroleum industry for all types of products will be greater during 1943 than they were in 1942.

Because it is more than probable that the demand for petroleum and petroleum products will be increased, it is particularly important (1) to increase the backlog of developed available reserves sufficient to provide the necessary sustained efficient productive capacity and (2) to undertake remedial work and to install facilities that will result in improving the efficiency of production operations in presently developed fields. Facilities of the latter type should include pressure maintenance and water-flooding installations, together with other work that will increase both recovery and efficient productive capacity in primary as well as in secondary production operations.

Although the over-all known crude reserves position of the United States is not unduly alarming at present, it could prove grossly inadequate if it became necessary to exceed the maximum efficient rate of production for long in order to supply the oil needed for the war. Any general and substantial increase in the rate of production from most present fields must be considered as an emergency measure to be adopted only as a last resort. The only area in which any important excess unused efficient productive capacity remains is in a limited number of fields in the southwestern states. Unfortunately, this available capacity is not readily accessible because of transportation difficulties which have resulted from the war. In the other important producing areas of the nation the ability to draw further upon the remaining reserves to produce sufficient quantities of the desired qualities of petroleum is uncertain. Production in excess of the maximum efficient rate would only accelerate the decline in the productive capacities of the individual fields and would also effect a serious reduction of the recoverable reserves in many cases.

Because of the foregoing conditions, one of the principal objectives of the Production Division will continue to be to encourage the petroleum industry first to increase and then to maintain the total reserves of the Nation at a level that will assure the ability to meet the likely demand of the war program. This can be accomplished only by accelerating the discovery of new fields. From its inception, the Petroleum Administration for War has considered exploratory activity and wildcatting operations to be of fundamental importance in winning the war. The results of wildcatting during the last four years has been consistently discouraging on account of the diminishing reserves found per wildcat drilled. It is estimated that, for the 3-year period, 1936-1938, inclusive, an average of 2,263 wildcat wells was drilled annually, which resulted in the discovery of an average of 806,000 barrels of new reserves per wildcat well. In the 3-year period, 1939-1941, inclusive, 2,963 wildcats were drilled each year, resulting in only 216,000 barrels of new reserves per wildcat well. Dating from 1934, the number of new fields discovered each year has increased consistently, but the size of the fields and hence the quantity of oil found per field has decreased as steadily from almost 20 million barrels per field in 1934 to 1.2 million barrels per field in 1941. Complete figures on the discoveries for 1942 are not yet available. The results, however, do not appear to be any better than for the preceding three years. It is estimated that approximately 3,100 wildcat wells were drilled during 1942. Based upon the poor record of discoveries in recent years, this number should be increased by at least 50 percent during 1943 and the industry should be prepared to increase its exploratory and wildcatting activity beyond this figure if it becomes necessary.

Striking a balance between the minimum quantities of critical materials that may be expended for urgent exploratory purposes and for extensive essential development drilling, the Production Division has outlined a program for 1943 involving the drilling of 4,500 wildcats and 11,500 development wells. Not only is it expected that this number of wells should be drilled, but this number of wells must be drilled if the required results are to be attained. Recognition is given to the continued difficulty of obtaining material, but it is proposed to direct even greater effort to assist the industry in procuring the materials required in conducting this essential drilling program, as well as for repair and maintenance of present production facilities and for necessary pressure maintenance and secondary recovery programs. In the order of their importance to the war program, first preference will be given to materials for wildcatting and related exploratory activities, next to materials required for repair and maintenance, next to materials and equipment required to drill and complete necessary development wells. Plans are being completed for further minimizing to a greater extent than formerly the time required to extend priority assistance for emergency repair and maintenance work in connection with wildcat drilling. Wildcat operators, faced with an emergency breakdown that threatens the safety of the well, will be able to obtain quick relief through telegraphic communication.

The total quantity of new materials available for drilling and production operations is rapidly approaching the irreducible minimum that is set by the War Production Board in relationship to the total requirements to the war program. In order

to provide sufficient materials for the wildcat wells that must be drilled during 1943, considering the smaller total amount of material that will be available for all purposes, it will be necessary for the industry to meet all production demands with the drilling of fewer development wells than were drilled during 1942. In order that the smaller number of development wells may yield adequate production, it is incumbent to exercise care in selecting the locations that promise to return the most oil per pound of steel or to "prove" the largest amount of acreage. To maintain present production rates it will be more essential than ever that advantage be taken in every field of the advance production practices that have been developed in recent years. It will be necessary to rework old producers, to increase the application of pressure maintenance and gas repressuring, to resort to return of water to the productive horizon from high-water oil ratio wells, to adopt secondary recovery by gas and artificial water drive, and to install and maintain such operations with the use of a minimum quantity of new material. The Production Division of the Petroleum Administration for War will continue to encourage every study and will aid in any plan whereby increased productive capacity may be obtained efficiently with a saving on steel as compared with the drilling of new development wells. Should consolidation of property interests or unitization of fields appear necessary or desirable to facilitate proper development and to achieve the most efficient producing practices, this office will cooperate in putting such plans into effective operation.

Anticipating the increased shortages of critical materials that will confront the industry during the coming year, the Petroleum Administration for War has requested the production branch of the petroleum industry to conduct studies of all fields in which materials now installed in production facilities may, if necessary, be reclaimed and made available for superior use elsewhere. These studies are now being developed actively under the supervision of industry committees and the results will become available during the early part of 1943. If some wells and other production facilities are, as a result of such studies, determined to be unnecessary to obtain the maximum ultimate recovery of oil, even though they might be continued in profitable operation in normal times, the industry will be prepared, if need be, to turn to these facilities to acquire a portion of the materials necessary to continue essential production and drilling operations during the last stages of the war.

Studies are also being conducted by the industry committees of the joint use of production facilities in order that effective use may be made of existing available manpower and equipment. Operators having facilities not presently "loaded" to capacity will be encouraged to share these facilities with adjoining operators. This Office will stand ready to assist in perfecting all such plans that are presented for approval.

In order to meet the increasing essential demands that will undoubtedly be made upon the petroleum industry to produce more and more oil with less and less equipment and material, the ingenuity, collectively and individually, of operators and technical men in the exploratory, development, and production branches of the industry will be taxed to the utmost. The industry as a whole is to be commended for the wholehearted, effective cooperation that has been evidenced thus far in the war. The counsel and assistance of the industry committees will be solicited to an even greater extent during the coming year through more effective relationships with these committees. The important task for 1943 is to assure adequate petroleum reserve and productive capacity to meet all war requirements. It is up to the production branch of the petroleum industry and the Production Division of the Office of Petroleum Administrator for War to see that these objectives are attained.

REFINING INDUSTRY FACES DIFFICULT PROBLEMS

Refineries Must Be Kept Running—They Face Serious Economic and Technical Problems of Adjusting Operations to Meet Dominating War Demands and Providing Trained Personnel for New Processes

By Bruce K. Brown

Assistant Deputy Petroleum Administrator

CHANGES imposed by the war make it difficult to forecast any general pattern for United States refining activities in 1943. Profound differences exist between the problems of the various refining areas and, indeed, between the problems of specific refineries within each area.

The diversion of tank ships to "combat duty," can be felt two thousand miles from salt water. East Coast war products plants are hard put to produce the maximum critical war materials on account of the highly restricted diet of crude available to them. East Coast refineries which do not produce critical war products simply can't run at all until the transportation situation is bettered. On the other hand, District 3 refiners of both war products and civilian products have a plethora of crude and finished products. More crude is being refined in District 3 than can conveniently be brought to market. District 2 refineries suffer both a crude shortage and a transportation shortage, but to a lesser degree than Districts 1 and 3. Districts 4 and 5 have also lost a part of their usual tank car transportation and District 5 must sustain the fuel oil demands occasioned by our war in the Pacific.

For the reasons suggested, refiners throughout the country are faced with a problem that is entirely new to most of them and which is mainly out of their control—namely, the all important question as to how best to move crude in and products out.

Further, even within the various Administrative Districts of the Petroleum Administration for War, there are certain problems specific to special areas. For example, Gulf Coast refiners can and do experience and sustain a demand for fuel oil along with other products, but in the interior of Texas, where local consumption of gasoline is light because of sparse population (even without regard to rationing), fuel oil demand is inordinately large because of the requirements of the railroads in that area.

Finally, profound differences may exist in the 1943 refining pattern of two immediately adjacent refineries running approximately the same daily quantity of the same crude—assuming that one plant is producing some critical war products such as 100 octane aviation gasoline and that the other is not. In meeting an increasing demand for fuel oil and a diminishing requirement for gasoline, refineries which are not required to concentrate on a maximum production of some specific war product have a greater freedom to

modify their refining operations. This technical advantage is offset by an economic disadvantage arising out of the imposition of price ceilings, thus far inflexible, based on a pre-war economy in which gasoline was the money crop and fuel oil sold in many areas at or below the price of crude.

The extent to which it has been possible to modify motor gasoline yields is well illustrated in District 3. During the last six months of 1941 the Gulf Coast plants produced a 40 percent yield of motor gasoline, based on crude. Most of these plants are now operating on rigid schedules drawn to permit the production of a maximum of one or more critical war products. In October 1942, while running approximately 80 percent as much crude as before, they had reduced motor gasoline yield to 28.5 percent. The inland plants of District 3 produced a 49.8 percent yield of motor gasoline during the last half of 1941. During October 1942 these same plants, most of which are not producing critical war products, running substantially 80 percent as much crude per day as in the last half of 1941, had reduced motor gasoline yield based on crude to 39.5 percent. The grand average of all plants in District 3 shows a motor gasoline yield based on crude of 31.0 percent for October 1942 as contrasted with 42.2 percent during the last half of 1941.

National gasoline rationing will almost certainly require further reduction in motor gasoline yields. In many parts of the country, refineries, in which the operation of cracking units is not necessary to enhance the yield of critical war products, should cease cracking entirely in order to produce maximum fuel oil and minimum gasoline.

The abstract logic involved is clear enough. Crude bought at, say, $1.50 a barrel and turned into fuel oil selling at 85 cents a barrel and gasoline selling at $2.25 a barrel, is an operation whose profitability is determined almost entirely by how much fuel and oil and how much gasoline is produced per barrel of crude. If refinery yield adjustments are accompanied by compensatory price adjustments the profitability remains the same. If such price adjustments do not accompany yield adjustments the profitability will certainly be lessened, but a lessened profitability does not necessarily retard production. But if, through failure to make adequate compensatory price adjustments, profitability for a particular refining operation disappears, the fuel oil and gasoline will not be produced in that refinery at all, and economic policy will be in violent conflict with production policy.

This war is a war requiring production, and, if economic policy and production policy are really thrown in violent conflict, product policy must prevail. Production must come first and we must have the essential products which can be produced in our refineries. Further we must have them in as nearly the correct proportion as refining technology—not refining economics—will let us have them. This naturally raises the question as to whether all of our refineries really must be maintained in operation or, on the contrary, whether the reduced civilian demand will not permit the least efficient of them to be shut down with a consequent saving in manpower and materials and a possible delaying of the day upon which some recognition must be given by the price authorities to the fact that the conversion from a gasoline economy to a war products-fuel oil economy requires some price readjustments. In the writer's view, it is entirely necessary that our refineries continue to operate.

The view held by some that refinery operations could be restricted in wartime with possible savings in manpower and materials appear to be based, first, on a failure to appreciate wartime requirements for fuel oil and second, on the mistaken assumption that ordinary motor gasoline, banned for civilian consumption for various reasons and by various methods, could be converted to the high octane product required for planes. Industry and government alike are bending every effort to adapt existing refining equipment and techniques to the conversion of what would otherwise be motor gasoline to aviation gasoline and toluene, but the problem can be solved only in small part during this war.

Aviation gasoline, toluene, butyl rubber, and butadiene are four essential war products for which definite requirements are established and for which definite construction programs are being executed. An overlapping service has been arranged under which most of the toluene, butyl rubber, and butadiene produced will be made in refineries which must run in any event to produce aviation gasoline. A year from now these refineries must run a very large volume of crude oil each day to meet these production schedules. I shall refer to this daily volume as "X barrels." A non-overlapping use of certain special crudes to produce aviation lubricants will require the additional running of "Y barrels" per day. Petroleum coke is just as essential to the war program as is toluene and there are certain minimum essential demands for fuel oil and asphalt. Computing fuel oil and asphalt requirements from present requirements and correcting for the probable effect of rationing and limitation orders, we find that the fuel oil, asphalt and coke by-products of the running of "X barrels" and "Y barrels" will not meet the minimum demand for these products and it will be necessary to run an additional amount of crude oil per day which I designate as "Z barrels" to obtain them.

A totaling of X, Y, and Z gives an answer as to the number of barrels per day of crude oil which must be run a year hence in order to satisfy minimum war needs. That figure is in excess of 3,800,000 barrels per day. It will be noted that we have arrived at that figure without once speculating on how much motor gasoline will be needed or should be used in our civilian transportation system. We simply have to produce that amount of gasoline — whatever it is — because our war products (except fuel oil) are really by-products of refining operations and we cannot produce any one product from crude oil without producing some quantities of some other products. I cite this figure to illustrate the point that our refineries must be kept running at a good clip if we are to produce the products required in this war. Of course, some new refining units will replace some old units and some uneconomical operations may have to discontinue.

Dislocations in transportation, failure of crude supply, and many other miscellaneous factors may affect the fate of any particular refinery but the operating pattern for all refineries is indicated by the figure cited. Actually, I know the figure is low. It was arrived at laboriously by checking the anticipated yields of war products from plants now built and building as adjuncts to our present refineries. The figures will have to be revised still more with increasing demands for aviation gasoline although we shall, of course, exert our best efforts to extract additional supplies of war products from those refineries which I included in my "Y and Z figures," that is, from the refineries which must run to supply additional needed increments of aviation lubricants, fuel oil, asphalt, and coke. Off shore shipments to our fighting forces cannot lower the figure—in fact every trend is in the direction of raising it.

During the year 1943 the synthetic rubber raw material plants dependent on petroleum raw materials will go on stream. The total butadiene to be produced from petroleum, while ordinarily measured in tons per annum, can be interestingly expressed in "refiners language" as a volume of about only 15,000 barrels per day or less than one half of the pre-war daily production of 100 octane aviation gasoline. As contrasted with a daily crude run of about 4,000,000 barrels, the quantity appears almost microscopic but the aches and pains which the industry has undergone in preparing to make it have been tremendous. New processes, new equipment, new governmental supervision, new types of business relationships, technical spats between proponents of various processes, shortages of construction materials, and the "hurry, hurry, hurry" of the demand for rubber have combined to plague the refiners involved, but by the end of the year all of the plants should be operating and the refiners can look elsewhere for interest and excitement.

During 1943 scores of refiners who have never before operated the various new processes—catalytic cracking, retreating, isomerization, alkylation, etc.—required for the production of 100 octane aviation gasoline will have to face squarely the operating problems which will come into being as soon as the plants are completed. Twenty-two major oil companies and thirty-five smaller companies are directly involved in the program. The task of adequately training sufficient personnel to cope with this production problem and the synthetic rubber raw material production problem is one which will require a high degree of cooperation between government and industry and between individual refiners.

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WHAT'S AHEAD

OF THE OIL INDUSTRY IN 1943?

Greater Absorption in War Activities—Huge Expansion in Production of War Materials—Further Extension of Government Control and of Pooling Supplies and Facilities—Industry Must Safeguard its Future.

DOMINATING all other factors affecting the oil industry in 1943 will be the very great expansion in war requirements that already is making itself felt. Most of the changes in operating methods, products, transportation and supplies for civilian use will hinge upon the ever growing demands of distant battlefronts for those petroleum products without which it is impossible to wage modern war.

For military reasons army and navy officials do not announce the amount of petroleum supplies being used to keep planes, tanks, guns, troops and ships moving at home and abroad. To do so would be tantamount to publishing the strength of the armed forces being put into the field. Partly because of this necessary reticence and partly perhaps because of the discussion that has revolved around the question as to when existing domestic shortages of gasoline or fuel oil or other oil products will be relieved the public, or at least a large part of the public, has formed the opinion that continued success on the part of the United Nations will mean that on the home front restrictions on the use of oil for motor fuel and home heating can be lifted or relaxed.

A very little thought will show the fallacy of this idea. Success for the allies depends upon putting more and more men and armor into action until their superiority in this respect reaches the point where the final knockout blow can be administered. As their forces grow the materials and supplies necessary to maintain them will increase in still greater proportion because of the constant rise in the tonnage of shipping required and because of the increase in the consumption of munitions and fuel as the fighting grows more intense. To move such an expeditionary force as the Americans landed in North Africa in November last requires hundreds of ships consuming fuel oil by the hundreds of thousands of barrels merely in making the voyage, to say nothing of the supplies needed for subsequent field operations. There will be many such expeditions as the number of American troops in service abroad rises from one to two, three and four million or more.

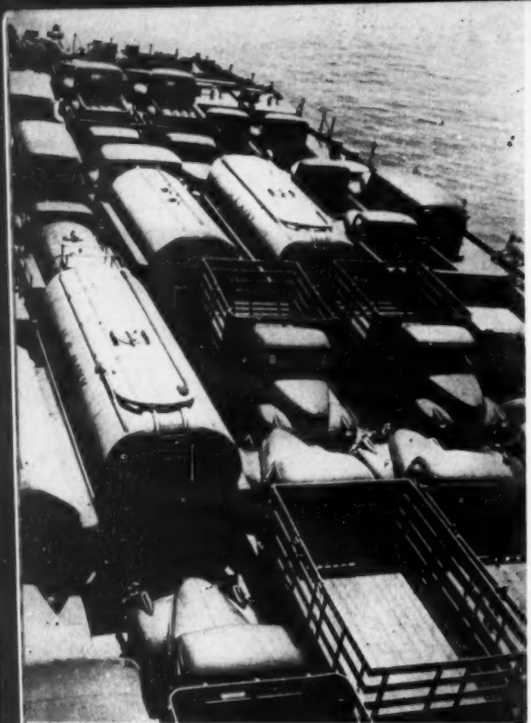
It requires no expert knowledge to understand that as thousands of planes are added each month to those previously in service, as tanks and trucks roll off the assembly lines in ever mounting numbers and as millions of tons of shipping are set afloat the task of keeping these machines of war in motion, a task that must be performed by the petroleum industry, assumes tremendous proportions. There is no secret as to the petroleum products mainly in demand for war use. Aviation fuel for airplanes, gasoline for tanks and trucks, fuel oil for ships, toluene for ammunition, butadiene for synthetic rubber, and lubricants for all manner of machines and vehicles, are among the important items — all on a scale that appears colossal as compared with anything in past experience. The production of 100 octane gasoline, multiplied over and over again in the past two years must again be doubled. Fuel oil, heretofore a by-product of refining operations, moves up to a place of commanding importance. Toluene requirements are fivefold what they were only a matter of months ago. And so on through the list. It all counts up to a situation in which 50 percent or more of an enlarged oil industry output will be required to support war activities and war production.

To meet special war requirements a vast amount of construction is being carried on by the oil industry and the investment in new facilities during the year will reach a total far above that of any previous similar period. Except for limitations imposed by the war itself activities in all branches of the industry would be expanding in similar fashion with a great increase in drilling, a rapid rise in production and a record breaking upswing in consumption. Concentration of the nation's resources, facilities and man-power on the all-essential task of winning the war, however, prevents this all-inclusive expansion. Lack of materials for drilling and of means of transportation sufficient to satisfy even the more urgent needs of the situation prevent the normal growth of the industry in certain directions, upset its established scheme of operation and raise economic problems of threatening proportions.

During the year just ended the greatest disturbance to the normal functioning of the oil industry was the withdrawal from its regular service of the big fleet of tankers which conveyed 1,250,000 bbl. daily of crude and products from Gulf Coast ports to the Atlantic Seaboard, supplying 95 percent of the latter area. By tremendous effort in building up the eastward movement of oil by tank car, pipe line and barge a great part of this huge gap in supply has been closed, but a continuous deficit has remained and its effects are written in the drastic rationing of gasoline and domestic heating oil throughout the East, in the closing of service stations and garages forcing thousands of men out of business, in the slowing down of refining operations both in the eastern area and along the Gulf Coast, and in a severe curtailment of the most profitable phase of oil marketing. While the movement of oil to the Atlantic Coast will be substantially increased with the completion of new facilities of transportation now under construction it seems improb-

Left: Drums of oil destined for the British war effort, being examined and tested before shipment.

Right: Off for a trial run. Each completed tank is given an extensive run over rough terrain to prove its many fighting advantages.



Oil tankers and trucks stowed fender to fender being transported to a U. S. outpost on foreign soil.

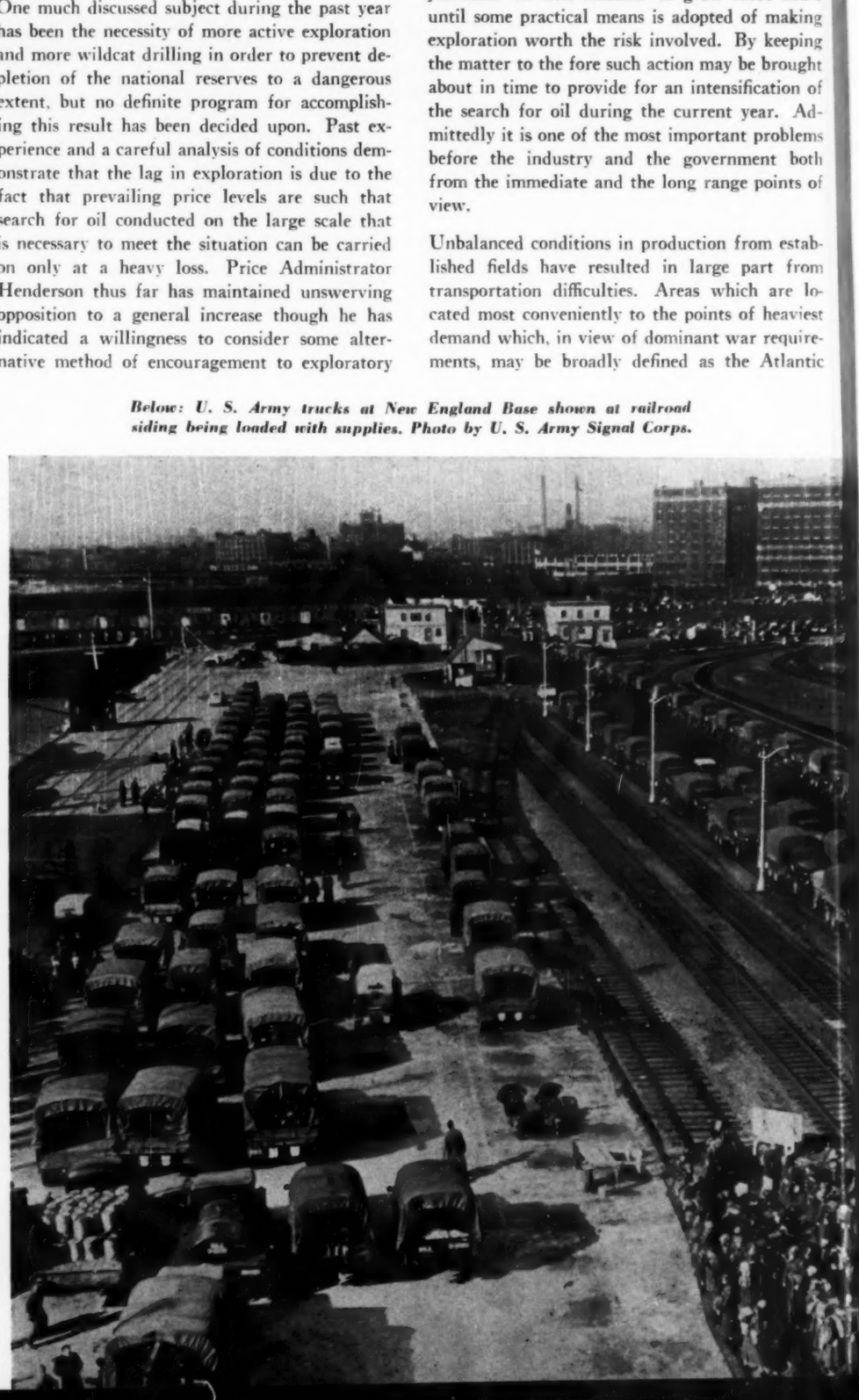
able that this will have much if any effect in relieving the internal shortage that has prevailed. All the additional oil that can be moved by rail, pipe, and inland waterways, possibly much more beside, will be required to maintain military operations—those of the United States and other members of the United Nations—across the Atlantic. Restrictions upon private use and consequent curtailment of marketing activities must prevail until the war enters its closing chapter.

Rationing in the eastern states has reduced the mileage of privately owned motor cars and their consumption of gasoline and oil by upward of 30 percent. Extension of this rationing to other parts of the country as a means of conserving rubber presumably will have a similar effect. The oil industry can count upon the loss of approximately one-third of its gasoline sales. Because of war requirements refiners will have to carry still further the changes in product ratios which have made themselves felt in 1942, increasing the amount of fuel oil produced from each barrel of crude and decreasing the recovery of gasoline. Within the past year the average production of gasoline from a 42-gallon barrel of crude oil has fallen from 45.7 percent to 37.5 percent or from 19.2 gallons to 15.7 gallons. As against this decrease the production of distillate and residual fuel oil has risen from a combined 36 percent to over 42 percent or from a little over 15 gallons to nearly 18 gallons. This puts refining practice back to about the stage of efficiency it had reached ten year ago. Technical retrogression would not be a serious matter under existing circumstances however if the market value of the products were the same. Unfortunately, with prices frozen at the 1941 level and actually falling below this in some sections, the preponderance of low priced fuel oil as compared with the higher selling gasoline results in a total return on the products obtained from each barrel of crude approximately 25 cents less than at the earlier date. With runs of 4,000,000 bbl. this will mean a daily loss of $1,000,000 as compared with a normal schedule of refined production. Correction of this condition is beyond the power of the industry since it has no control over the prices to be charged for its products. These are determined by the federal Price Administrator but the situation is so serious, threatening the very existence of a large section of the industry, that the necessity of some measure of relief is admitted as the only means of avoiding economic disaster and some action along this line is to be anticipated.

One much discussed subject during the past year has been the necessity of more active exploration and more wildcat drilling in order to prevent depletion of the national reserves to a dangerous extent, but no definite program for accomplishing this result has been decided upon. Past experience and a careful analysis of conditions demonstrate that the lag in exploration is due to the fact that prevailing price levels are such that search for oil conducted on the large scale that is necessary to meet the situation can be carried on only at a heavy loss. Price Administrator Henderson thus far has maintained unswerving opposition to a general increase though he has indicated a willingness to consider some alternative method of encouragement to exploratory drilling. No practical means of providing this has been worked out thus far but the urgency of action to counteract the reduction in underground reserves becomes daily more evident and the question is one that cannot be shelved indefinitely. Since wildcatting imposes relatively small demands for critical materials the extension of such operations would not interfere with the full persecution of the war program. The Office of Petroleum Administrator is strongly in favor of increasing exploratory drilling during 1943 by 33⅓ percent or more if possible which would mean putting down between 4,000 and 5,000 such wells. The problem remains one of economic adjustment. It will continue to grow more acute until some practical means is adopted of making exploration worth the risk involved. By keeping the matter to the fore such action may be brought about in time to provide for an intensification of the search for oil during the current year. Admittedly it is one of the most important problems before the industry and the government both from the immediate and the long range points of view.

Unbalanced conditions in production from established fields have resulted in large part from transportation difficulties. Areas which are located most conveniently to the points of heaviest demand which, in view of dominant war requirements, may be broadly defined as the Atlantic

Below: U. S. Army trucks at New England Base shown at railroad siding being loaded with supplies. Photo by U. S. Army Signal Corps.

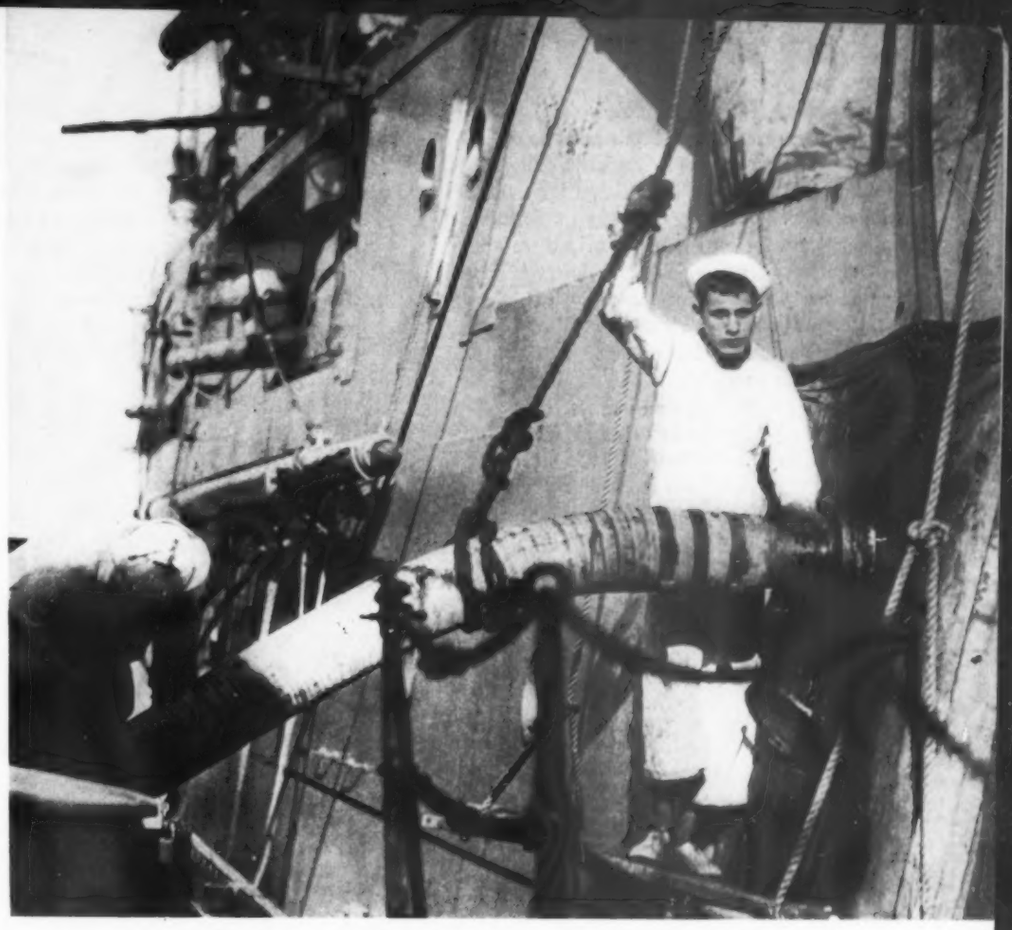


and Pacific coasts, are producing up to the limits and in some instances perhaps beyond the limits of safe conservation. Other fields located beyond reach of rapid transportation have had to curb their output below the volume which they could reasonably supply. This latter handicap can be overcome only as relief from the pressure of armament demands permits the extension of pipe lines or other means of transport. Meanwhile refineries not engaged in production for war are threatened with complete shutdown.

Restrictions upon the supply of drilling equipment undoubtedly will continue to limit drilling within proven fields although the promise is held out that some improvement over 1942 may be possible this year. One phase of the production situation to which the government is directing its attention is that of increasing the output of types of crude best adapted to the provision of such war materials as high octane gasoline, aromatics and fuel oil. The designation of Sumner T. Pike, SEC Commissioner, as a special aide to Price Administrator Henderson is announced as a move toward the determination of means of attaining this objective. Among these means price adjustments are said to be included.

One phase of production which calls for constructive action is that represented by stripper or marginal wells which constitute three quarters of the country's total. Here again the problem is primarily economic and so beyond the immediate control of the industry. At present prices a great number of these wells cannot cover their cost of operation. Owners find it to their advantage to close down the wells and junk their equipment rather than to keep them in operation but this means the permanent loss of the oil that they are still capable of producing and abandonment on a broad scale would deprive the country of oil that it cannot afford to waste. Maintenance of these small wells in operation and encouragement of methods of secondary recovery that would add a billion barrels or more to their ultimate yield are problems that deserve early attention and constructive action.

One development clearly in sight for the oil industry during the coming year is a greater degree of government control and regimentation imposed by the demands of total war. This movement, already well advanced, includes the pooling of supplies and facilities of distribution, the elimination of the healthy competition that has given the public a grade of service hardly equalled by any other business and a combination of producing, refining and transporting activities that may involve temporary elimination or loss of identity for individual units. The dangers involved in such steps can be justified only by the absolute requirements of a war for survival. They are accentuated by the obvious predisposition among certain agencies of the federal administration in favor of governmental control and management of business as a settled policy. One of the big tasks before the oil industry is to make sure that the drive in this direction is carried no further than the exigencies of war require, that it is acknowledged as a temporary expedient only and that it does not lead to permanent loss of the free exercise of initiative which has enabled the industry to achieve the unexampled progress of its past history and which is the only means of maintaining that progress for the future.



Refueling a battleship. Keeping these machines of war in motion is the chief responsibility of the oil industry.

The oil industry has not failed in meeting every demand made upon it thus far in providing the essential materials of war in the full measure required of it. Its members have devoted their energies and resources without regard to private interests to furthering the war effort. At the present time an unprecedented expansion of facilities is under way to prepare for the fulfillment of still greater demands. The ability to satisfy these will be limited only by the extent and speed with which the materials of construction and operation are provided. The industry is committed 100 percent to the winning of the war and all other considerations are and must be subordinated to that. So far as the means and measures requisite for final victory are governed by its own resourcefulness and technical ability it will be able to answer every call. The most serious difficulties confronting it at the present time arise from conditions and regulations beyond its own control, some of them unavoidable and some of them arbitrarily imposed.

Aside from the disruption of its highly developed facilities, the loss of revenues from accustomed sources and the restrictions upon its usual provisions for progressive development the most serious problems confronting the oil industry at the beginning of 1943 are those of an economic nature. It is obvious that no industry can maintain its efficiency over an extended period unless it is kept in sound financial health. The oil industry in particular has made its outstanding record of progress in the past by investing a large proportion of its earnings in the replacement and enlargement of the reserve supplies needed to meet ever growing industrial demands. It has spent hundreds of millions of dollars every year in technical research to raise the standard of its products and to develop new ones. Through active competition within its own ranks it has steadily improved the quality of its products and reduced their cost to consumers. If it is compelled now to forego the hope of a reasonable return on its operations or to rely on grants from the government to make good heavy losses which it has been forced to assume in the performance of emergency service it will lose the very qualities that have made it strong and able to contribute so materially to the nation's greatness.

Among the multitude of problems confronting the industry in 1943 two of outstanding importance are:

To preserve a sound financial structure, sacrificing customary profits but not undermining future efficiency.

To keep open the pathway for a return to the system of free initiative and private enterprise when the present emergency is over.

NATURAL GAS AN IMPORTANT ADJUNCT OF OIL INDUSTRY

By Dr. O. W. Willcox

Tremendous Resources, Not Fully Developed, Supply Equivalent to Half Billion Barrels of Fuel Oil, Contribute Importantly to War Effort and Provide Base for Expanding Chemical Industry.

THE NATURAL GAS INDUSTRY is generally regarded as a sort of little brother to the oil industry. This may be true in a relative sense, but the natural gas industry has a large importance in its own right. Regarding only its function as a supplier of heat units, the nearly three trillion cubic feet of gas which the industry is producing every year contains the equivalent of at least 100,000,000 million tons of coal, or about 500,000,000 barrels of fuel oil. The natural gas industry has an enormous investment in its tens of thousands of gas wells and its more than 90,000 miles of pipe lines to innumerable communities in 34 states and the District of Columbia. It is estimated that 35 million people in the United States are direct users of natural gas; indirectly, through the industrial uses of natural gas, practically all the people of this country are benefited.

In one important respect the natural gas industry differs from the oil industry. Oil may be shipped in drums and tankers to any part of the world, but gas must be consumed at home, where it is making itself felt in the nation's war effort in a way that is perhaps too little appreciated. Think of the enormous additional quantities of coal and oil that would have to be produced if there were no gas wells. Every extension of a gas pipe line to a new group of gas users liberates an equivalent amount of oil for shipment to our fighting forces and our allies among the United Nations. This fact alone might be cited in justification of extending every possible aid to the gas industry for expanding its facilities. The natural gas men are already doing a big job of expanding with such materials as they have. Competent authorities estimate that the output of natural gas in 1942 will exceed that of 1941 by an average of 25 per cent; in some areas the increase will be as much as 40 percent.

Like all big and little industries the natural gas industry is faced by numerous problems, both short range and long range.

The short range problems arise from the impact of the war, which has brought to the industry increased demands by the great mushrooming of industry, coming on top of the normal annual increase in the use of gas by the civilian population. This annual increase is about 10 percent each year. To meet this abnormal increase the industry has to struggle with a shortage of materials, a shortage of labor, increased cost of operation and supplies, and heavy new taxes. It is having to make its arrangements with only indefinite information as to requirements for its products, it has also to struggle with difficulties of official or legal origin that prevent the orderly drilling of new wells.

Among the more immediate of the problems of the natural gas industry is the matter of available reserves, with emphasis on the qualifying adjective available; taking the country as a whole the proven gas reserves of the United States are enormous, amounting to some 85 trillion cubic feet, which is enough to last, at the present rate of consumption, for 25 years. Relatively, the reserves of natural gas are greater than the reserves of oil, which have been figured to last somewhat less than 20 years at present normal rates of withdrawals.

The unfortunate fact is, however, that the rate of withdrawal of natural gas from its underground reservoirs is subject to some restrictions imposed by nature. A sand may contain billions of cubic feet of gas, but an 8-inch well drilled into the sand will be able to deliver only a certain quantity a day, even at full open flow. Experience has shown that open flow in many cases has a disastrous effect on ultimate recovery, particularly in fields with water drive; for this reason, and as a conservation measure, many states prescribe that gas wells shall not be operated at more than 25 percent of open flow, and in some cases the maximum allowable rate is only 15 percent, and even less; a very low rate.

The natural gas industry is therefore up against the problem of the "deliverability" of its commodity, and in the face of greatly increased demand the problem is a large one. The most effective way of meeting the delivery problem would be to increase the number of wells in a natural gas field. For that, the industry would have to obtain the materials and supplies needed for drilling, and also some relief from existing restrictions on the spacing of gas wells.

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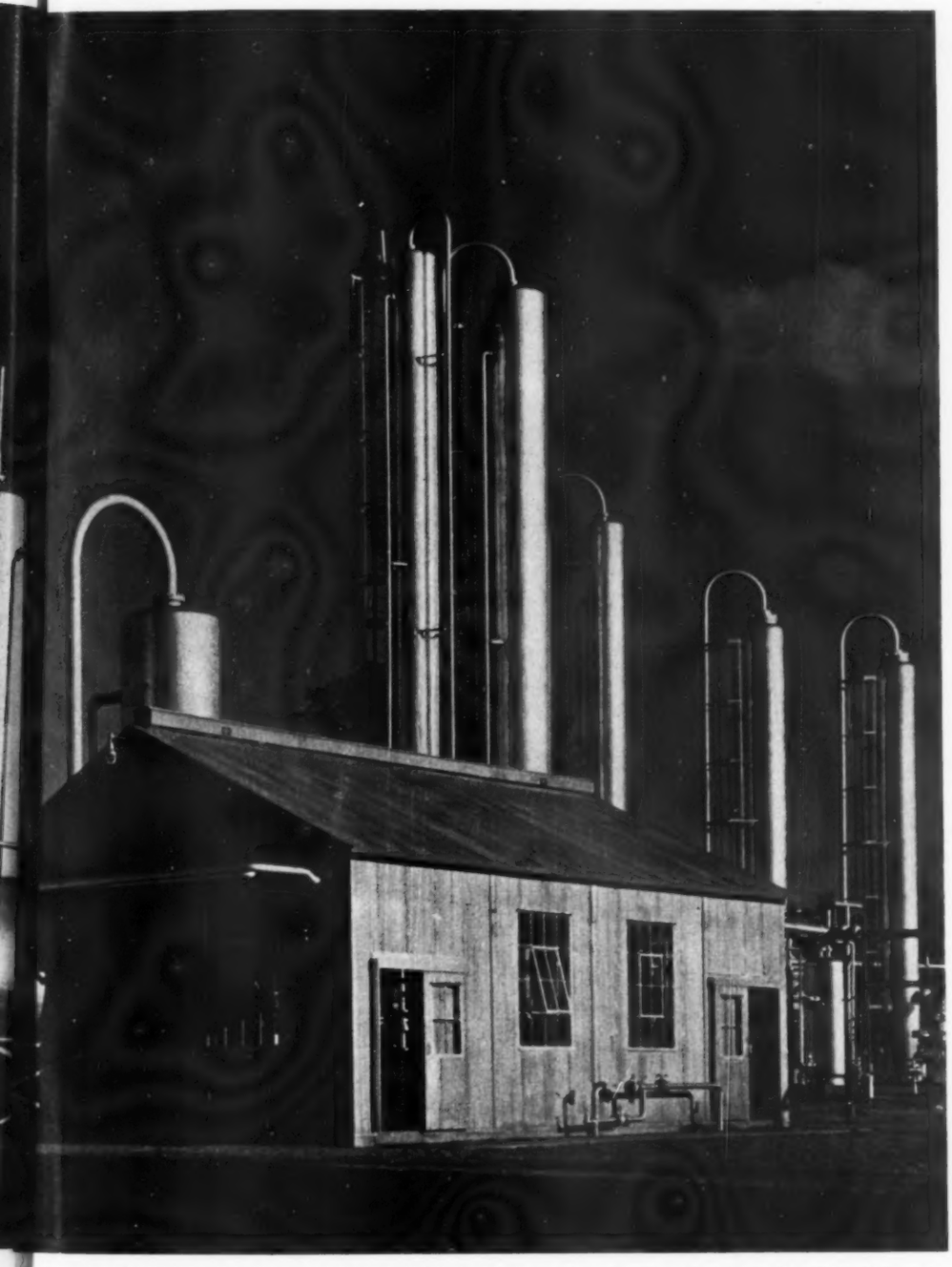
umption of natural gas is affected by the sea-on. The peak comes in winter, and during the winter, blizzards, which occur at irregular intervals, create emergency demands. From the nature of the case the production of natural gas is a well-to-burner business; accumulation of an emergency reserve for peak demands is difficult. Aside from sinking additional wells to be kept shut in for emergency use, there are two solutions. One is to install facilities for liquefying the excess of gas during summer and keeping it in cold storage for winter use. This has been successfully done on a large scale in Cleveland. The other is to store gas during slack periods in old depleted or near depleted gas sands, from which it could be drawn by the turn of a valve.

This is an excellent means, if a depleted or vacant sand is at hand, which is not always the case. A number of regulatory bodies are exerting themselves to encourage this method of storage in all possible cases. An effort is being made to pass legislation that would give natural gas companies the right of eminent domain to condemn for this purpose any suitable underground formations in their vicinity. Still, the drilling of extra wells for emergency use remains as the most direct and universally available method of meeting the deliverability problem but this depends on the availability of drilling supplies.



Part of the recycling plant of the Lone Star Gas Company in Texas; showing part of the processing area.

The existence in the United States of a proven reserve of about 85 trillion cubic feet of natural gas is, on the whole, a comforting fact, but is subject to qualification by the uncomfortable circumstance that this reserve is inconveniently distributed.

Natural gas geographers recognize five major areas in which gas is produced and consumed in the United States. The first to be commercially exploited was the Appalachian field, lying within the states of New York, Pennsylvania, West Virginia, Ohio. This field is estimated to contain proven reserves of about five trillion cubic feet, with a possibility that another five trillion remains to be discovered. The most important source of natural gas in this field is West Virginia, and the least important is New York State. In spite of notable discoveries of deep Oriskany gas, the production of gas in Appalachia has exhibited a slow decline.

This decline in Appalachia is especially inconvenient from the fact the Appalachian region is now crowded with war industries which demand great quantities of this handy fuel. Since the entry of the United States into World War II the natural gas industry in this region has been forced to make a strenuous effort to maintain production at a rate sufficient to meet the demand. For a time these efforts were thwarted by the War Production Board's order M-68, which restricted the drilling of new gas wells. The effect of this order soon showed itself in the war industries of the region; the Board saw the error of its way and modified the order, and drilling activity in the region is again very intense—within the limits of available drilling materials. This episode illuminates the need of a liberal policy in the allocation of materials for drilling new gas wells to meet urgent war demands, and this policy might well be further liberalized to permit the drilling of stand-by wells for use during the inevitable peaks.

The current rate of natural gas delivery from the wells of Appalachia is about 400 billion cubic feet a year. Some observers feel that if the war continues for one or more years a very critical situation will be created in this important consuming region unless more wells are drilled, or supplemental supplies are brought in from other regions. Some immediate relief is in sight through an extension of the main line of the Panhandle Eastern Pipe Line Company, and additional lines from the South are projected.

Proceeding westwardly, the next natural gas region is the North Central area, comprising the states of Michigan, Illinois and Indiana. This region is a relatively very minor one containing only an estimated 200 billion cubic feet, with potential reserves of a similar extent. This field is of importance to the local communities; how long this local supply will last is problematical, and will depend largely on whether Illinois succeeds in curbing the waste of gas produced by its oil wells.

NATURAL GAS AN IMPORTANT ADJUNCT OF OIL INDUSTRY

By Dr. O. W. Willcox

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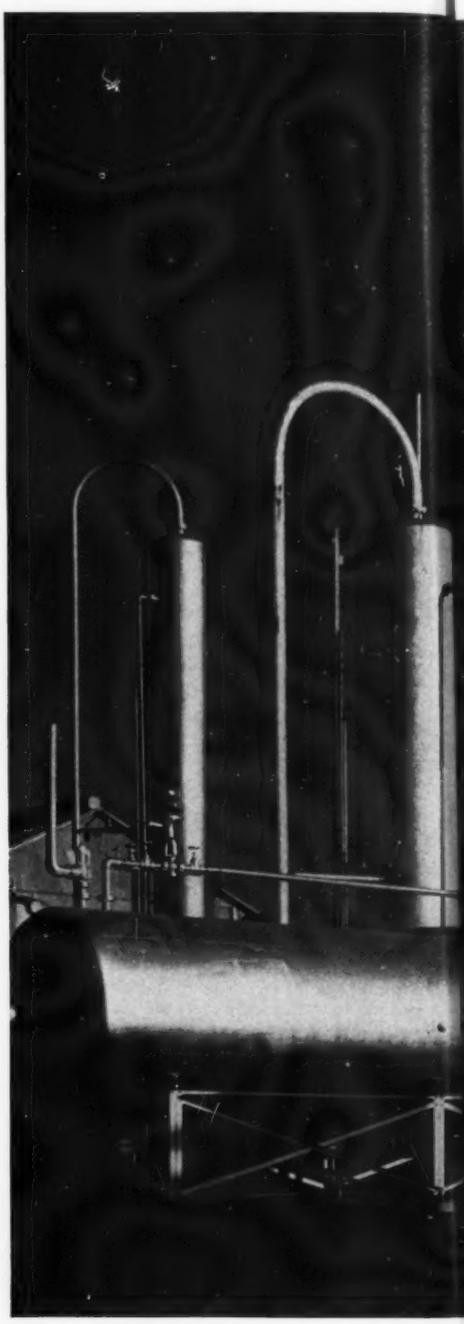

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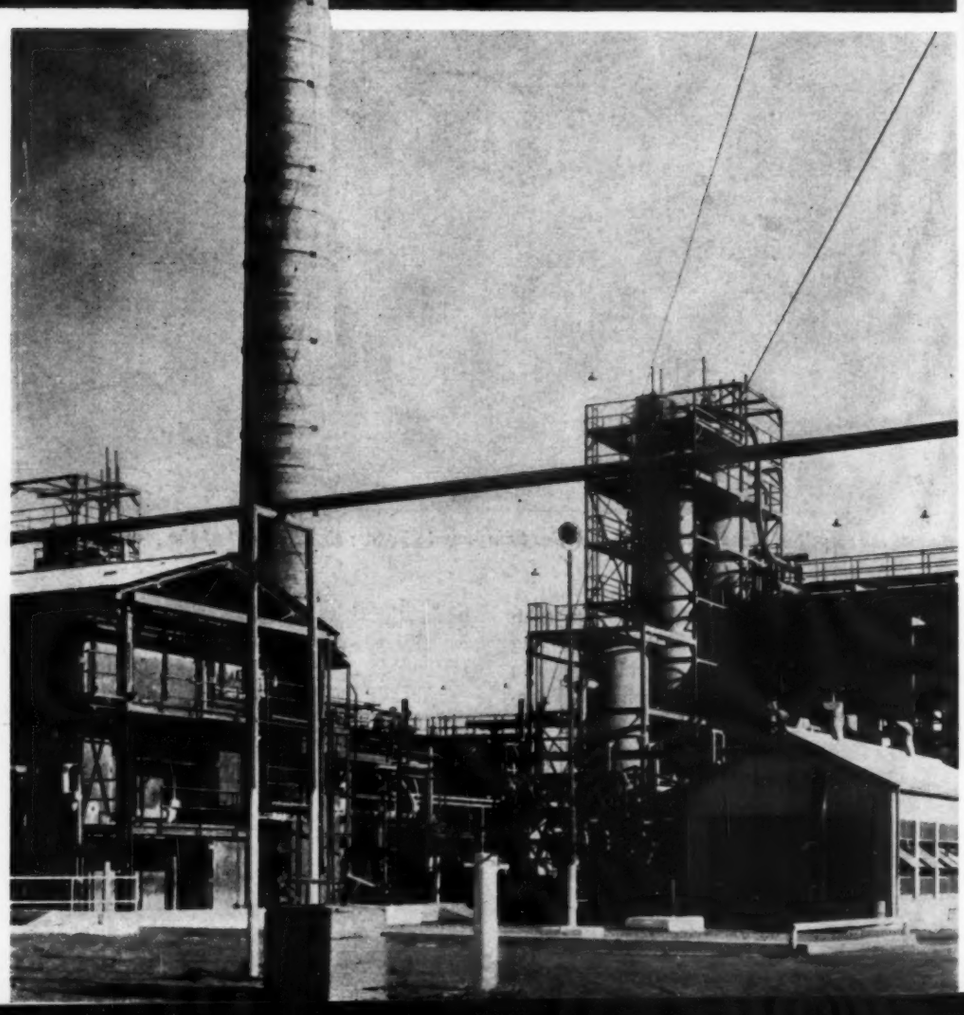
Above: This metering and regulating station of one of the Southern California Gas Company's plants is capable of handling 50 million cubic feet of gas daily.

The nation's riches in natural gas lie predominately in the Mid-Continent—Gulf-Coastal region, in which are included Texas, Louisiana, Arkansas, Oklahoma, Kansas and Southeastern New Mexico. Taken altogether this area has proven gas reserves amounting to about 70 trillion cubic feet, which is about 80 percent of the total gas reserves of the whole country. Two fields, the Amarillo and the Hugoton, which cover parts of the Texas and Oklahoma Panhandles and Southwestern Kansas, contain proven gas reserves in excess of 30 million cubic feet. There are numerous other gas fields and oil fields which produce oil and gas scattered over this great region; some of them, as in Eastern Kansas and Northeastern Oklahoma, are old and largely depleted. The region of the Sabine uplift, where Northwestern Louisiana, Southeastern Arkansas and East Texas meet, has proven reserves of three trillion cubic feet. The Monroe field in Northeastern Louisiana is also credited with proven reserves of the order of three trillion cubic feet; since this field was opened to date it has produced more than three trillion cubic feet. In



Right: Naphtha gas reversion unit of the Phillips Petroleum Company.

the Permian basin of West Texas, Southeastern New Mexico the proven reserves are probably of the order of four to five trillion cubic feet. This region is still awaiting gas pipe line facilities. In numerous scattered areas in North and Central Texas the proven recoverable reserves amount to two to three trillion cubic feet.

Besides the approximately 70 trillion cubic feet of proven gas reserves credited to the Mid-Continent—Gulf-Coastal region, petroleum engineers "suppose" that there are potential reserves of an equal amount. This estimate of potential reserves is predicated on the fact that gas production in the past has come from relatively shallow formations. On a report made before the Interstate Oil Compact Commission, R. E. Davis says that additional substantial reserves will undoubtedly be discovered by deep exploration in Western and Southwestern Oklahoma and in the Gulf Coastal Plain, just as deep Oriskany drilling in Appalachia has in recent years helped to keep up production in that region. As a matter of fact, many new gas fields have been discovered on the Coastal Plain, and in spite of the fact that new oil reserves are becoming increasingly difficult to discover "there is no indication that we will have any early difficulty in adding to our known gas reserves whenever it may be worthwhile to do so."

Also, in estimating potential gas reserves it is considered permissible to include what is now considered as "unrecoverable residual gas." At present a gas sand is considered depleted when, under existing economic circumstances, production becomes unprofitable. However, if easily produced natural gas becomes scarce and cost and price get sufficiently apart, depleted fields may become profitable again.

The fourth major natural gas area of the United States comprises the Rocky Mountain States; Montana, Wyoming, Colorado and Utah. The known gas reserves of this region are not great when compared with those of the Mid-Continent. Montana has "at least" 750 billion cubic feet, and the other three states about the same amount. There are a number of known structures and likely areas not yet explored which perhaps contain potential reserves of a large order.

The fifth natural gas area is California. This state is the only one that does not pipe any gas out nor pipe any in; the whole production is consumed at home, and the state has a larger number of gas consumers than any other state. Most of the gas is obtained from wells that also produce oil. The known gas reserves are thought to be 9 or 10 trillion cubic feet. Potential reserves are uncertain, but further exploration and deeper drilling may uncover additional large amounts.

While the known supply of natural gas in the United States is of the order of 85 trillion cubic feet, the inconvenient circumstance remains that in certain regions the supply is small and the demand for gas is great and exceedingly important. One result of this situation is that the Appalachian and adjacent regions often find it exceedingly difficult to take care of swollen demands, and meet emergencies and peaks, while Texas and Louisiana have far more than is needed locally and still see much gas going into the air as waste. It is a situation that confronts the gas industry with one of its important long range problems—how to enable consuming centers to get enough for their needs, and enable producing centers to market their surplus product.

The answer to this problem is a judicious extension of the system for distributing natural gas through pipe lines. The extension must be "judicious" in order to avoid mistakes and unpleasantness that have occurred in the past. It has happened before that communities and even large cities have been converted from the use of manufactured to natural gas, only to find that the field on which they depended became depleted, and they had to go back to manufactured gas again. To avoid further discredit of this kind future pipe line projects must be based on known reserves of large extent, made up, if necessary, by interconnecting numerous small fields. A pipe line company, on entering into agreements with producers in composite fields, should guard against depletion by requiring the producers to carry on a continuous drilling program to meet normal demands, and to maintain sufficient delivery capacity to meet the shock of peaks and emergencies.

Out of this situation we can draw the conclusion that the more than 90,000 miles of gas pipe lines now existing are not nearly enough.

Another problem of the natural gas industry, and one which is of paramount interest from the standpoint of the national welfare, is the problem of conservation. The 85 trillion cubic feet of proven gas reserves constitute a precious resource which will last a longer or a shorter time, depending on what success the regulatory bodies, aided by the cooperation and good sense of all members of the industry, have in suppressing the waste that is still going on. Much has been done and is still being done to prevent waste of this

Battery of Clark 800 hp. "angle" pressor units in Gulf Plains rec plant.

national resource, but in the past gas fields and gas-producing oil fields have been handled in profligate disregard of the future. It has been estimated that for every four cubic feet of natural gas produced in the United States between 1906 and 1940, inclusive, at least one cubic foot has been squandered into the atmosphere. As late as 1940, when the total metered production was about 2,655 billion cubic feet, the Bureau of Mines estimated that 656 billion cubic feet, or about 20 per cent, had been wasted. In a few striking instances, as in such fields as Amarillo, Oklahoma City and Rodessa, waste has been on a colossal scale. Much if not most of the waste has been caused by the absence of markets, which in turn has been due to the absence of facilities for transmitting the excess of the product from remote fields to actual and potential consuming centers. The problem of conservation of this irreplaceable national reserve will therefore be wholly solved when a network of pipe lines has been developed that will reach every gas-producing field and every gas-consuming market.

But time flies, and gas is wasted while the needed systems for distribution are developing. In the meantime, the nation cannot sit idly by and see this invaluable component of the national wealth dissipated uselessly into the air. Many of the states have long been endeavoring to control the waste of gas in their territories. The Interstate Oil Compact Commission, which now includes practically all the important petroleum producing states, has embarked on a program for promoting conservation.

For ascertaining the facts regarding the production, conservation, and utilization of natural gas the Commission has caused a survey to be made of the major producing states. In Arkansas the wastage of natural gas from any gas well by escape to the air is definitely prohibited, and waste of gas from oil wells prior to its efficient use in the production of oil is controlled by gas-oil ratio regulation. As a result, the Arkansas Commission is able to report that no gas that can be commercially utilized is wasted in that state. Colorado also reports "very little" wastage of natural gas, amounting to 367 million cubic feet in 1940 out of a total of nearly three billion, or about 12 per cent; this is below the general average of 20 per cent but is still to be regretted.

Illinois became an important petroleum producer only a few years ago and has made a very unenviable record for natural gas wastage. According to figures from the Illinois Geological Survey, 21 fields from which data could be obtained produced, in the first seven months of 1942, 53,517 million cubic feet of gas and 48,101 million or about 90 per cent, was vented to the air. About the same percentage of waste is recorded for the years 1939 to 1941, inclusive. An unfortunate circumstance in this connection is that nearly all Illinois gas comes from oil wells, and by its expansion drives the oil to the well bore. By allowing the gas to go to waste instead of using it for repressuring Illinois producers have seen their production of oil decline, and have lost substantial quantities of reserves that would have been recoverable. Repressuring so far has been done mostly in the Louden pool.

In Kansas most of the oil pools are undersaturated with gas and there is consequently little gas wasted in casinghead operations. In other pools gas-oil ratios were as high as 30,000 and wastage was a problem. The Kansas Commission took the matter in hand, reduced the legal ratio to 3000, and prohibited venting of casinghead gas. This forced the operators to undertake remedial work, make use of formation packers, and to install compressors to return the gas to the formation after stripping it of natural gasoline, propane, and butane. Waste of gas in that state is now characterized as "relatively unimportant." The history of legislation in Louisiana to prevent waste of gas goes back to 1906, with supplemented laws since then. This state has so much gas that new fields which promise to produce only gas are left undeveloped. None the less, the Louisiana Department of Conservation has put forth much effort to prevent wastage of this superabundance. The best it could do in many cases has been to set very low legal gas-oil ratios, and reduce any oil wells allowable production of oil in proportion as its gas-oil ratio exceeds the legal limit; a well owner who has gas-oil ratio of 33,333, for example, would be allowed to produce only six percent of his normal allowable. The result is to divert most of the oil production to wells having low gas-oil ratios; all gas above the legal limit may be wasted. The State has a number of distillate fields, and by means of its power to enforce unitization the Department of Conservation has prevented much waste by promoting recycling projects.

In Michigan the first gas fields were rapidly and wastefully developed. As regards gas wells the authorities took control in 1937, but authority to regulate the production of oil wells did not come until 1939. This regulation improved matters, but it is reported that out of an estimated total of 1,334,970,000 cubic feet of casinghead gas produced in July, 1942, only 109,970,000 cubic feet (80 percent) was metered and used, and the rest was vented into the air. This is waste at the rate of more than a billion cubic feet a month in a region which has a comparatively small reserve.

In the great Hugoton area in Oklahoma gas production from dry gas wells has been under good control, but until recently large volumes of gas produced with oil have been blown into the air. In recent years the State Oil and Gas Conservation Department and the Corporation Commission have bestirred themselves to stop this waste. Gas-oil ratio tests are frequently made and operators are shown the desirability of using packers, bottom hole chokes and other rational production practices. In cases of wells with very high gas-oil ratios, the well is allowed to produce no more oil than corresponds to the market demand for the gas produced with the oil. Reinjection of excess gas is strongly urged, but can hardly be enforced because of lack of steel and equipment. It is now considered that gas waste in Oklahoma is negligible relatively.

Texas is the state that produces more oil and gas than any other. Not many years ago gas was being wasted on a stupendous scale. The Railroad Commission has succeeded in ending the more obvious forms of waste but is still struggling with the more subtle types of waste that occur within the reservoir which tend to reduce ultimate recovery of oil. Chief reliance is placed on control of gas-oil ratios. A standard ratio of 2000 has been set. Any well producing in excess of 2000 cubic feet of gas per barrel of oil is automatically penalized by having its allowable reduced. The aim is to test every well periodically to determine its gas-oil ratio and relatively excellent results have been obtained. However, with the facilities at its command the Commission cannot test every well in the state, and there is still a sizable amount of waste. During the first six months of 1942 some 982 billion cubic feet of gas were produced in Texas. Eighty-two billion cubic feet were used for recycling and pressure maintenance, and 43 billion were vented to the air. This waste is less than one half of one per cent of the total, but in any event 43 billion cubic feet is a lot of gas, and would last a large community for a long time. The Commission is doing the utmost to promote recycling and repressuring projects.

At the present moment the Interstate Oil Compact Commission faces the fact that despite improvement in the conservation of gas some oil fields are being operated with inefficient gas-oil ratios, and some are without facilities for utilizing the gas. Its Research and Coordinating Committee is studying both angles of the problem, and has called on the state regulatory bodies to make intensive studies on each of their oil and gas reservoirs. Its recommendations include the promotion of return of excess gas for pressure maintenance; erection of natural gasoline and chemical plants for production of liquefied petroleum and chemical raw materials for synthetic products; the promotion of gas consumption for fuel and industrial purposes; the sealing off of gas sands in fields from which there is no market outlet.

The Compact Commission's Regulatory Practices Committee recommends that the state pass separate acts for gas and for oil, because these two products are so different that they can best be regulated independently; these laws should be as uniform as possible; the movement of natural gas should be regulated at its source rather than after it has passed into the hands of the gas companies. The gas act of each state should be drawn so as to give every encouragement to underground storage as a provision for peaks and emergencies, even to the point of giving the gas companies the right to condemn adequate underground storage. Each state should have a ratable coking (prorating) law, including common purchaser and/or common carrier provisions.

One of the objectives of the Interstate Oil Compact Commission is to promote the "erection of natural gasoline and chemical plants for conversion of gas to gasoline, liquefied petroleum gases, and chemical raw materials for synthetic products."

For a long time to come the chief outlet for natural gas will be as a fuel for domestic and industrial use. Along with this major use, the employment of components of natural gas as a source of chemical products has had a large growth in recent years. The manufacture of carbon black from natural gas has been practiced for years; the carbon black industry was formerly very wasteful of this natural resource, but this is on the way to being remedied by the introduction of highly efficient processes.

Production of liquefied petroleum gas has also been long established, and has been a source of much convenience to homes and small power plants not connected to gas pipe lines. In 1941 this branch of the petroleum industry accounted for five percent of all natural gas marketed and in volume was equal to about a third of all manufactured gas. It is estimated that liquefied petroleum gas furnishes more than 2,000,000 American families with a high quality low cost fuel. More than 100 communities and small cities are served by local gas companies which distribute liquefied petroleum gas, brought in by freight, through piping systems. Utility companies even in large cities, unable to accumulate a reserve of gas for peaks and emergencies, keep on hand a supply of liquefied petroleum gas for stand-by purposes. The economy of this practice has been demonstrated in cases of interruption of pipe line service.

Besides these uses, a chemical industry based on the use of natural gas as its raw material began to develop several years ago. This new industry is busy furnishing key materials that are fundamental necessities for the whole organic chemicals industry, including dyes, explosives, medicines, solvents, plastics and synthetic rubber.

An example of a chemical plant based on natural gas as the raw material is the chemical plant of the Cities Service Company at Tallant, Oklahoma. Here, methane and other natural gas hydrocarbons are successfully transformed by air oxidation into methanol, formaldehyde and acetaldehyde, which are indispensable products for many purposes and are of tremendous importance for the war effort. Another example of the production of key materials from natural gas is the manufacture of synthetic alcohol from ethylene, which is obtained by thermal cracking of natural gas hydrocarbons. This is being done on a large scale by the Shell Oil Company and some others. The total amount of alcohol now being produced from ethylene is about 65,000,000 gallons a year. This alcohol is earmarked for use in the manufacture of smokeless powder for military purposes, and butadiene for synthetic rubber.

Another chemical offshoot of the natural gas industry that is just getting under way is the manufacture of acetylene from propane and other light fractious obtained from casinghead gas. Acetylene is one of the base materials used in the manufacture of synthetic rubber and nylon. This very important chemical is now mostly obtained from calcium carbide which is produced by an expensive electrothermal process from limestone and coal. It can undoubtedly be obtained more cheaply by thermal cracking of natural gas. At any rate, two commercial units, one having a capacity for 75 tons of acetylene a day, are now being installed.

There are other vastly important chemicals to be derived from natural gas. One of these is ammonia, which besides innumerable other essential uses is greatly needed as a fertilizing material. Ammonia is a compound of nitrogen and hydrogen; the former is obtained from the atmosphere and the latter is easily obtained by cracking natural gas; any natural gas region may thus create a synthetic ammonia industry.

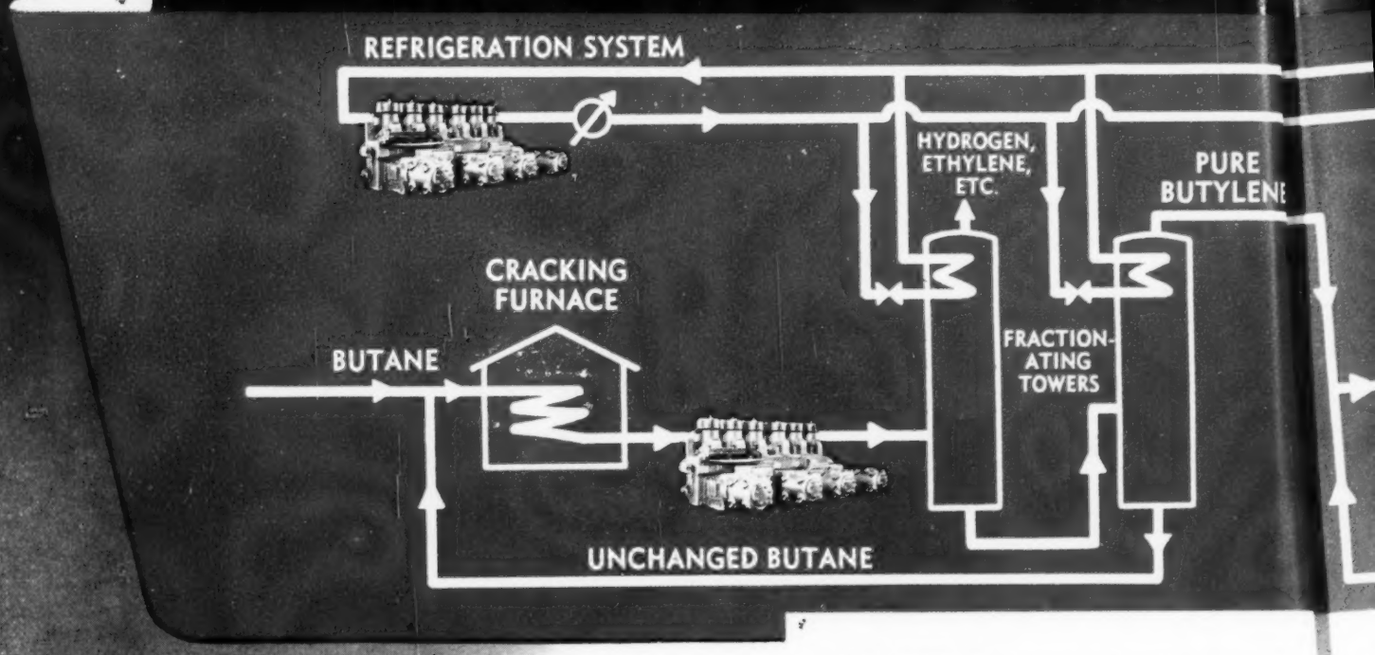
A possibility which is now approaching realization is the manufacture of glycerine from components of natural gas. Glycerine is now obtained from the hydrolysis of fats, and is needed so urgently that the government is calling on housewives to donate their waste kitchen fats. Glycerine is used in the manufacture of trinitroglicerine, employed in dynamite and other explosives. Farther in the future is the manufacture of soaps and edible fats from natural gas and other petroleum products. Still farther in the future for the United States (although the Germans are now doing it from dire necessity) is the use of methane for the production of synthetic petroleum, including a number of highly interesting substances not found in the natural product.

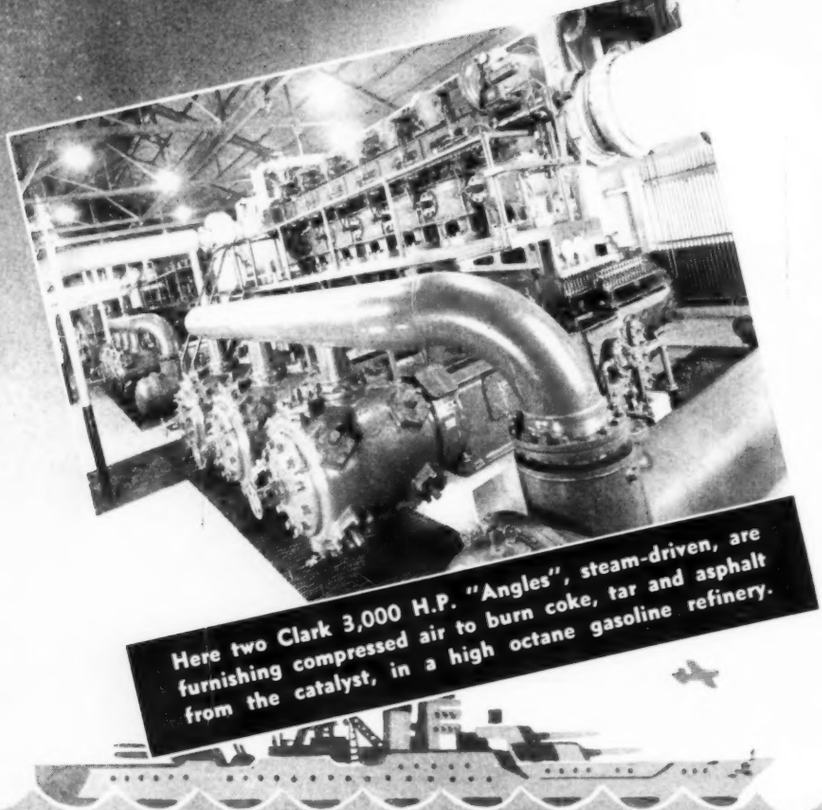
It is practically certain that the chemical industry which has been founded on natural gas will have an assured place after the war. It is in a strategic position to furnish the raw material for the important olefins—acetylene, ethylene, propylene, the butylenes and the pentylenes, from which practically every commercial organic product can be synthesized, directly or indirectly. In particular, natural gas will continue to make its contribution to the supply of 100 octane gasoline, which will be demanded not only for the future cargo and passenger airplanes, but also for the new engines which the automobile companies are already designing.

The United States has been forced by the war to create a whole new synthetic rubber industry. Undoubtedly this industry will continue after the war, in whole or in part. If so, its base will most likely be butane, which the American oil industry is producing at the rate of nearly 100,000 barrels a day. Most of the synthetic rubber plants that have been built were designed to operate on butylene by a roundabout process, but after the war, when there will be time to concentrate on the most efficient process, butadiene, the main constituent of Buna S rubber, will probably be made direct from normal butane by a simple catalytic process.

Line looping operations in Iowa of Natural Gas Pipeline Company of America's pipeline from Texas to Chicago; looping existing 24 inch line with 26 inch line.

CLARK COMPRESSO





Here two Clark 3,000 H.P. "Angles", steam-driven, are furnishing compressed air to burn coke, tar and asphalt from the catalyst, in a high octane gasoline refinery.

AMONG the scores of processes so far developed in making synthetic rubbers of the various types — one of the heavy volume roles will be that of the manufacture of Butadiene, the petroleum product from which the Buna N and Buna S types of rubber for automobile tires will be produced.

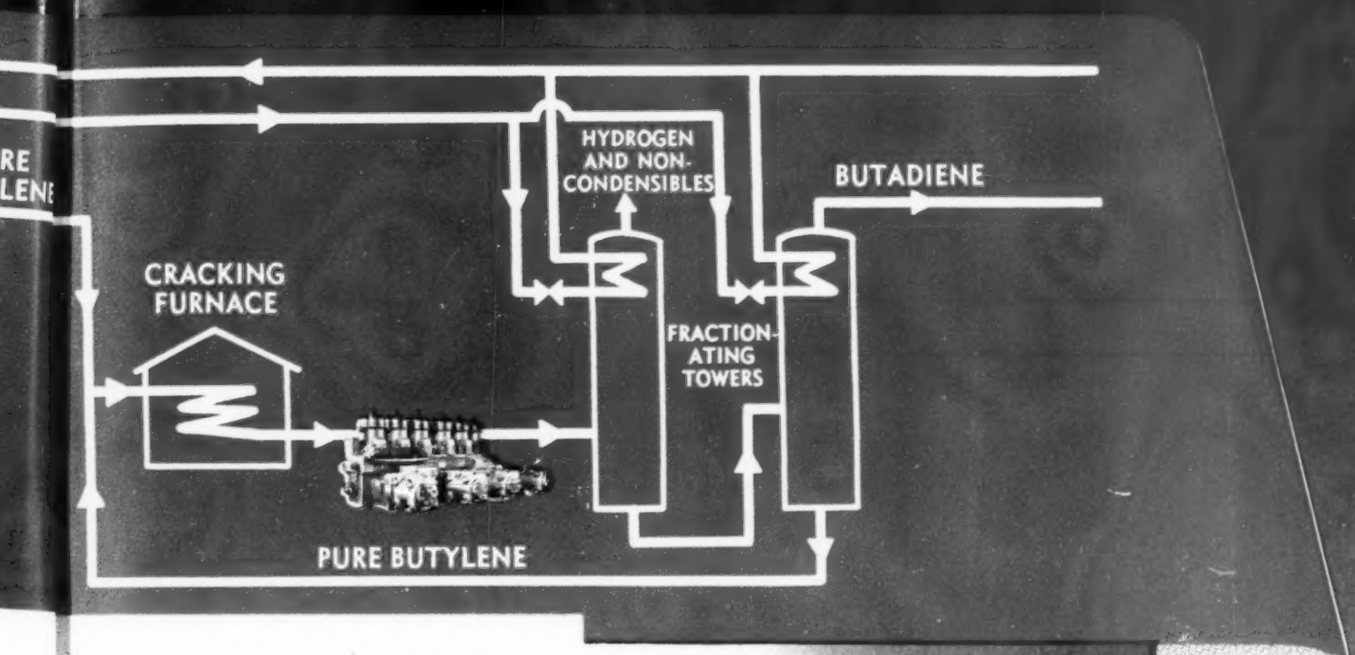
The simplified flow chart shown above indicates the part that CLARK Compressors will play in many leading Butadiene plants. They will be used for compression of gases for charging the fractionating towers and for refrigeration.

These processes are typical of the services that CLARK Compressors are being called on to perform in all types of synthetic rubber plants. In one type of plant CLARK Compressors will produce temperatures in the neighborhood of 150 degrees below zero.

CLARK Compressors are also used in the manufacture of Styrene from petroleum—the

CL

SSRS *for* BUTADIENE



material which is combined with Butadiene to form Buna S Rubber. They are also in tremendous demand for many war industries not connected with rubber. They perform major operations in the manufacture of high octane gasoline, high explosives, synthetic alcohol, synthetic ammonia, and many other chemicals and materials needed for the war production program. Clark engineers have had intimate contact with these war industries from the start and understand their compressor problems. Call them into consultation.

CLARK BROS. CO., INC., Olean, New York

Export Offices: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Texas; Chicago, Ill. (122 S. Michigan Ave.); Boston, Mass. (131 Clarendon St.); Huntington Park, Calif. (5715 Bicket St.) Foreign Offices: 72 Turnmill St., E. C. 1, London; Avda Roque Saenz Pena 832, Buenos Aires.

Affiliated Companies: Dresser Manufacturing Co., Bradford, Pa.; Pacific Pump Works, Huntington Park, Calif.; Bryant Heater Co., Cleveland, Ohio.

ARK

Huge Compressor Batteries of this type are being installed by Clark, in many leading plants for the manufacture of both Buna and Butyl types of synthetic rubber.

LOOK SOUTH, PETROLEUM EDUCATORS!

Exchange of Technical Information Between North and South America and Closer Cooperation by Representatives of Education in Mineral Industries Urged as Mutually Advantageous.

By Edward Steidle*

THE WRITER attended the first Pan-American Congress of Mining Engineering and Geology as an official representative of the Commonwealth of Pennsylvania. This meeting which convened January 14-23, 1942 in Santiago, Chile was the first opportunity for representatives of the mineral industries of all the Americas to discuss their mutual problems. The journey proved to be a striking example of a shrinking world. By the use of air travel it was possible to attend the session, cover some 22,000 miles in transit, and return to the office in an elapsed time of a little over three weeks. As a result of this experience and of many trips in the past to Middle and South America the writer believes that there are certain definite trends in evidence related to the mineral industries including the petroleum industry. These trends are of immediate importance to the industries; likewise, to the educational facilities available for the preparation of men for service in the various branches of these industries.

With the growing concern about the future of the oil reserves of the United States, Government and oil companies are looking to the countries of Middle and South America for a solution. This is not the first time that this situation prevails. At the end of the first World War, a shortage of reserves again loomed to become critical in the near future and active prospecting and development of oil lands in the Latin Americas were carried out. In order to protect their natural assets from predatory development by foreign interests as well as to encourage orderly development of mineral resources, many of the Latin American countries have enacted mineral legislation particularly with respect to the production of oil. Certain countries such as the Argentine and Mexico almost completely exclude foreigners from oil operation within their political boundaries whereas other countries encourage the development of oil concession with restrictive provisos attached to the grant often in the form of restricted import of both technical and labor manpower.

There is no escape from the fact that the tendency in the Latin Americas is toward a more intensive nationalization of their mineral heritage, especially petroleum. Yet, if our own oil reserve outlook is not improved within the span of a very few years we must look for increased imports of crude oil from abroad and it is natural that such oil should be purchased amongst our "good neighbors." Perhaps, nothing could foster friendly relations within the Western Hemisphere more than international trade without restrictive import duties, and crude oil looms large in this Hemisphere's future balance of trade. On

Bank of extractors for removing fluids contained in oil well cores and for determining fluid saturation.

* Dean, School of Mineral Industries, The Pennsylvania State College, State College, Pennsylvania.

an equal plane, perhaps, to promote closer relationship between the Americas, is the development of the natural resources of the Latin Americas on the basis of sound collaboration between capital and technical skill of the nationals of all of the Americas. If this policy is to prevail it will include in part the training on a much larger scale than presently of Latin American nationals for technical positions in the industries of their own countries, and the encouragement of such training as well as the exchange of students and scholars is a service to which the American government and institutions of higher learning might well give serious consideration.

South American Travel to North America should be encouraged by the establishment of a tourist dollar which could be purchased at a very substantial discount from the current exchange. Young people in one year of experience and study in a foreign country can learn more related to social, political and economic developments than they could acquire in an equal amount of time spent in any other manner. A mutual acceptance of responsibility for the support of our ideals will result from better acquaintance by our youth with the arts, literature, history and culture of our neighbors. Greater attention to the teaching of Spanish and Portuguese in the public schools of the United States must be encouraged. Nothing would do more for our Good Neighbor policy than making American textbooks, especially in engineering and technical fields, available to South American countries, and offering membership in our professional societies to them at reduced rates. Unfortunately, college students and instructors could ill afford $6 or $7 textbooks at the current rate of exchange. German textbooks are used largely in some countries because the German government foresaw the need, had the books translated, had them printed locally with cheap labor on cheap paper, and sold them for prices the people could afford to pay. As a result, the Germans built up good will. South American professional men would like very much to join our technical societies but membership dues of $15 to $25 a year are impossible at the present rate of exchange.

Above all we desire a basis of friendship supported by such sound and honorable fundamentals that it will endure and thrive in times of peace. It is undeniable that we become more concerned about cooperation in times when our national security is threatened or even at stake than we do in the more nearly normal times of peace. In part this is a perfectly natural reaction. In war years we see our commerce interfered with, our domestic economy disrupted, and national existence in jeopardy. As a matter of course we turn to our neighbors for support and assistance, particularly as we know that they have much to contribute, since they have faced similar problems. Every country has as much to lose as the next. But if in these times of stress we can forget some of our selfish interests and learn to appreciate the particular capacities and skills of others, then we can create a common ground of understanding and mutual appreciation which can be extended and expanded in the future.

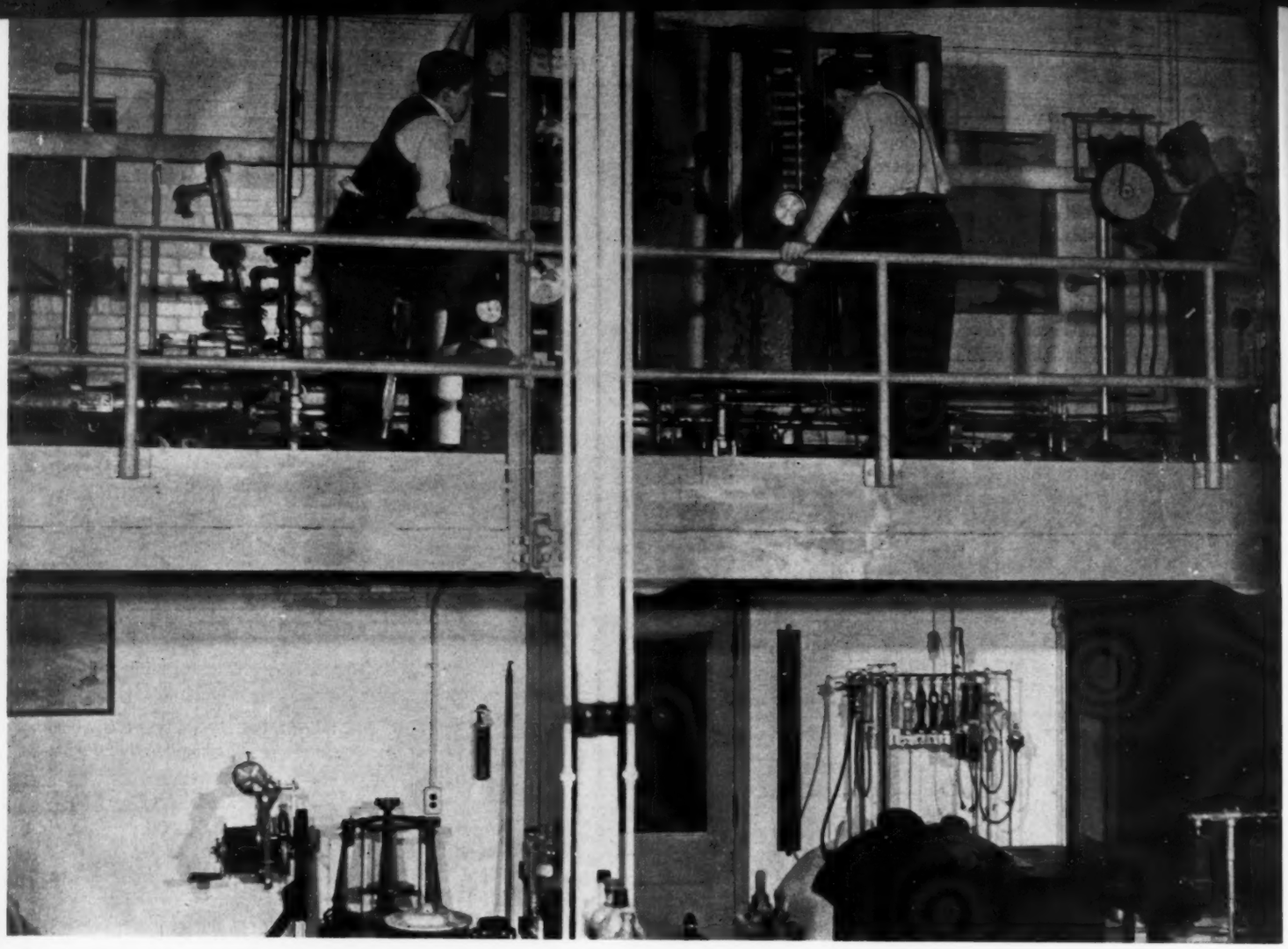
View of experimental well of the Pennsylvania State College showing students using an oil well dynamometer.

Perhaps the most important result of the Congress was the mutual recognition by the representatives of all nations that the Americas face a common problem of defense in the present emergency and possibly even more serious social and economic readjustments in the post-war years. Therefore, recommendations were made by resolution of the Congress with the intention of establishing good neighbor policies on a permanent basis. It was recommended that a Pan-American Institute of Mining Engineering and Geology be located permanently at Santiago, Chile. This organization is to cooperate with all the mineral industries societies of the Americas, support all activities that will benefit the mineral industries, and expand fundamental knowledge of geological conditions and encourage the standardization of technical terminology. The Institute will also facilitate the interchange of publications, students, professional men and industrialists connected with the mineral industries. This free exchange of men and ideas may well become the most effective bond uniting the Americas in their attack on common foes and economic disaster.

In this world of changing technologies it is significant that the section on mineral industries education, which represents a cross section of all the Americas, reported the opinion that technical training should be divided into three stages. The divisions of training would be concerned with the training of men for service in the mineral industries in three distinct grades. The first would be at craft level, the second technical, and the third university. Due to the increasing frequency of exchange of mining engineers and technologists between the Americas, university training should be on a comparable basis. Minimum and uniform requirements for the granting of degrees in mineral technology would be established in institutions properly equipped to merit approval. As an indication of the trend of thought with regard to the importance of the mineral industries in modern industry, it is of great interest that the section on education recommended that instruction in mineralogy and geology be included in the field of secondary education. This instruction would be taught on an equal basis with zoology and botany. The three fundamentals of existence, plants, animals and minerals, would thereby receive equal attention.

The whole spirit of the Congress can be summarized as one of cooperation in which the representatives of the different countries pooled their knowledge and abilities to formulate a working plan of action for the benefit of all in the future. That this plan will succeed in creating a permanent and stable basis for the benefit of all the mineral industries, of all the Americas now seems assured. A second Congress will be held at Rio de Janeiro, Brazil, in May, 1944. As a means of supporting the interests of this Congress, the writer believes the following suggestions to merit consideration:

Why not give an all-out expression of appreciation to the Chilean Institute of Mining Engineers which initiated the First Pan-American



Gas metering and regulating equipment in use by a class of students at Pennsylvania State College.

Congress of Mining Engineering and Geology? The Congress was made up of fourteen sections representing every branch of geotechnology.

Why not give total support to the Second Congress which is scheduled to be held in Rio de Janeiro, Brazil, in 1944, with the fundamental purpose of securing united effort and leadership by the advancement of the interests of all branches of earth sciences, mineral economics, mineral engineering, and mineral technology in the Western Hemisphere to forestall a "have not" position in the world?

Why not make the Pan-American Union, Washington, permanent headquarters and pro-rate expense among the Americas on an equitable basis. Chile financed the first Congress and agreed to finance temporary headquarters, Santiago, in good faith.

Why not rename the Congress the Pan-American Congress of Mineral Industries and when we say American why not agree to include and protect the interests of Middle and South America with a view to hemispheric solidarity and self-sufficiency?

Why not try to instill in ourselves an Inter-American consciousness? Such a habit of thinking of the twenty-one nations as friendly and cooperative equals in the conduct of social, professional and business relations will achieve the solidarity of the Americas, develop commerce and finance, and spread civilization, enlightenment, and culture throughout the world.

Mauricio Nabuco, Secretary-General of the Brazilian Foreign Ministry at last January's Rio conference, said, "It would be better for a United America to lose this war than for America to remain disunited, for a united America would rise from defeat, but if a part of us won and part of us lost, we would remain divided forever."

That mineral industries education thrives best under centralized control on a given campus rather than distributed under diverse administration seems evident. That those charged with the problems of administration will have many such problems in common is also apparent. An organization which would assist in the exchange of ideas and the solution of mutual problems would certainly be of value. And in these days of a shrinking world in which distances of thousands of miles means little, such an organization might well serve the whole hemisphere. The expansion of the mineral industries and their increased development in a post-war world is sure to be rapid in the republics to the south of us. There must be at least 1000 men concerned with educational phases of the mineral industries in the United States and 100 in the Latin Americas. They are not united with any common aim directed toward future progress or a proper recognition by the public of the importance of their efforts in the fields of instruction and research. It seems logical that a closely knit association of mineral industries schools which would permit the exchange of ideas and the formation of a common front for mutual aid could contribute much in the solution of post-war problems which inevitably will be manifold in number and serious in scope.

Why not revive the National Association of State Mining Schools under the name American Association of State Schools of Mineral Industries, to include all of the schools in the Western Hemisphere and with the teeth that are necessary to further the interests of the schools? The Section on Education of the First Congress opened the door for such an Association. Why not prorate expenses among the school members on a basis of enrollment? To me these are actionable suggestions, but all of them will require able leadership. Why not act now?

Foreign Oil Legion

SELECTION of Edwin D. Cumming as Director of the Division of Refining in the Office of the Petroleum Administrator for War is an appointment that meets the hearty approbation of members of the refining industry among whom he is a well known figure. He brings to his new post a long experience in the practical operations of refining, demonstrated executive ability and a command of the technological problems involved in the production of the special war materials which are now the chief concern of the industry. Besides this equipment his frankness and geniality provide him with a valuable equipment for dealing with the knotty questions which involve a reconciliation of conflicting viewpoints.

Born in Troy, Ala., Mr. Cumming received his early education in Birmingham and graduated in 1922 from the Alabama Polytechnic Institute after a course in chemical engineering. His first position with the oil industry was as chemist with the Barnsdall Oil Company. From there he went to the Shell Oil Company in California where he advanced to the position of manager of the Martinez refinery in 1937 and a year later was transferred to St. Louis as manager of the company's great Wood River plant. Shortly afterward he was made a vice president of the company in charge of manufacturing and when Shell's St. Louis offices were removed to New York in 1940 he shifted his headquarters to the latter city in general charge of refining activities.

R. W. HAMLET who spent many years in the foreign service of Socony-Vacuum Oil Company has been appointed Assistant Treasurer of the company. He joined the Standard Oil Company of New York in 1912 and after completing his training for the foreign field was assigned to the North China Division as marketing assistant in the Tientsin District. He became manager in Chungking and was later transferred to Shanghai as marketing assistant for the whole North China Division. Returning to New York City in 1920, he became marketing assistant for the Levant Division, travelling extensively in the Near East and in various parts of Europe and Asia. In 1929 he was appointed purchasing agent of the company and, following the merger of the Standard Oil Company of New York and the Vacuum Oil Company in 1931 he was assigned to the Treasurer's Department as assistant to the treasurer.

THOMAS A. J. DOCKWEILER has been elected to the board of directors of Tide Water Associated Oil Company succeeding the late George N. Armsby. Mr. Dockweiler is a resident of Los Angeles and prominent in law and business circles on the Pacific Coast, is counsel for several oil companies and otherwise interested in the oil industry.

A. M. Chesney

ANDREW M. CHESNEY of the Atlantic Refining Company of Brazil at Rio de Janeiro recently completed an extensive survey of river transportation and petroleum product marketing facilities throughout the Amazon River Valley and contiguous areas in Bolivia and Peru. This study was undertaken at the request of the Rubber Reserve Company in connection with their rubber production program in the Amazon Basin.

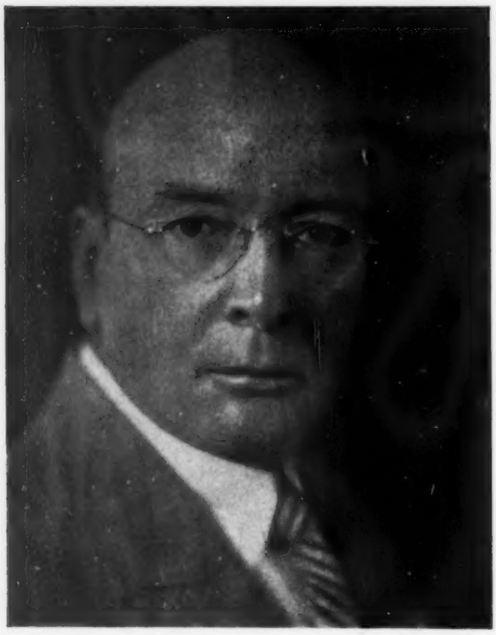
WHEN the new Congress assembles in Washington early this month the Senate will have the unusual experience of numbering among its members a practical oil man. This is E. H. Moore of Tulsa who succeeds to the seat from which the voters of Oklahoma retired Senator "Josh" Lee at the November election. Senator Moore was born on a Missouri farm, earned his way through normal school and supported himself by teaching while preparing for the law. He set up practice in Okmulgee, Okla., in 1900 and, beginning in 1908, gradually acquired a number of small oil properties. In 1919 he organized the Independent Oil and Gas Company which grew to be an important factor in the Oklahoma oil industry up to the time when it was purchased by Phillips

Petroleum Company in 1930. Since then he has conducted operations under his own name while devoting much of his time to his farm near Okmulgee. He has been a lifelong Democrat but outspokenly opposed to many New Deal policies and ran against Senator Lee on that issue as a coalition candidate with Republican endorsement.

SUMNER T. PIKE, a member of the federal Securities Exchange Commission, has been designated as a special assistant to the Price Administrator in Washington. It is reported that his special function will be to deal with problems of price adjustment. Before his appointment to the Securities and Exchange Commission in 1940 Mr. Pike was associated with a firm of New York investment bankers.

Sumner T. Pike

DEATH TAKES WILLIAM S. FARISH



THE sudden death of William S. Farish, president of Standard Oil Company (N. J.) from a heart attack, at Middlebrook, N. Y. on November 29, deprived the oil industry of one of its most active and outstanding leaders. For many years he had taken a prominent part in movements connected with the progress of the industry, being an early advocate of conservation efforts and an ardent supporter of everything contributing to technical progress. He was a member of the Petroleum War Service Committee in World War I, one of the organizers and an early president of the American Petroleum Institute. From the start of the present national emergency he had given unstintingly of his time and energies to furthering the oil industry's service to the cause of the United Nations both through the operations of his own company and as a member of the Petroleum Industry War Council and chairman of its committee on the protection of petroleum facilities. His labors in this connection together with the heavy load of his executive responsibilities are believed by his associates to have been responsible in some measure for his death. In the words of William R. Boyd Jr., president of the American Petroleum Institute "he was truly a war casualty."

Mr. Farish was born in Mayersville, Miss., in 1881. He graduated from the University of Mississippi in 1900 intending to enter the law but the oil boom set off by the Spindeltop discovery in the following year attracted him to Texas where he presently formed the Brown-Farish Oil Company and engaged in the contract drilling business. In 1917, together with R. L. Blaffer, Ross Sterling, H. C. Weiss and a few others Mr. Farish organized the Humble Oil and Refining Company of which he was vice-president. The rapid rise of the company to a leading position among Texas producers and refiners is well known and it led to a union of the company with Jersey Standard. Mr. Farish by that time had become president of Humble and remained in that position until 1933 when he was made chairman of the Standard board. In 1937 he and Walter C. Teagle exchanged positions, the latter taking the post of chairman while Mr. Farish assumed the presidency.

IN DECEMBER the Axelson Manufacturing Company in Los Angeles replaced a blue star in its big service flag by a gold star honoring Lieutenant Blaine Cole. Lieutenant Cole, former engineer for Axelson, and well known in both the Mid-Continent and California, was the first man from Los Angeles to give his life for his country in the Allied invasion of North Africa. As an officer engineer in the amphibious forces, he was killed in the landing at Casablanca.

JOHN H. KUNKEL, director of public relations and advertising for the Fluor Corporation, is serving as president of the Industrial Advertising Association of Southern California for the 1942-43 term. The association is a chapter of the National Industrial Advertisers' Association and is composed of advertising men and sales executives interested in the fields of industrial advertising, sales and marketing. Its monthly meetings are devoted to the discussions of these subjects.

John H. Kunkel

KOBE MANAGEMENT PROMOTIONS

J. C. COBERLY, president and general manager of Kobe, Inc., has announced the appointment of C. M. Rader as assistant general manager and of H. K. Browning as general sales manager. In making this announcement Mr. Coberly said these changes were made to meet the increasing demands of the company's business due to its war contracts and rapidly spreading use of the company's hydraulic pumping system for the production of crude oil essential to the war effort. Mr. Rader, formerly general sales manager, will be responsible for all hydraulic pump and perforated pipe activities of the company, and will continue his headquarters in Huntington Park, California. He was graduated from the University of Minnesota's school of civil engineering, immediately entered the officer's training course at Fort Snelling, Minn., and later served with the Twentieth Engineers in France during 1917 and 1918. On returning to civilian life in 1920 he joined the engineering group of the Mid-West Refining Company. Later he became connected with the Indian Territory Illuminating Oil Company where he served as assistant to the vice president and general manager of the company. In 1931 he went with the Phillips Petroleum Company and in 1937 joined Kobe, Incorporated, first as division manager and later as general sales manager at Huntington Park. Mr. Browning will have charge of the company's sales, field and advertising activities in both the domestic and foreign markets for all products.

After attending the school of civil engineering at Cornell University Mr. Browning joined the A. M. Byers Company as manager of oil country sales. Interest in pumping and corrosion problems caused his association in 1934 with the S. M. Jones Company. Mr. Browning joined Kobe, Inc., in 1940 as division sales manager and in April of this year replaced Mr. Rader as Mid-Continent division manager.

C. M. Rader

H. K. Browning

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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry — Edited by Dr. O. W. Willcox.

REFINING

The Thermofar Catalytic Cracking Process—T. P. Simpson, L. P. Evans, C. V. Hornburg and J. W. Payne, before Refining Division, AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1942.

The Thermofar catalytic cracking (TCC) process is one of the major new developments in the art of catalytic cracking. The development of the process has been carried through the semi-commercial stage in a 500-bbl.-day plant to the present design of commercial units ranging in oil-charging capacity from 2,500 bbl. to 10,000 bbl. per day. The process operates on the principle of continuous catalyst flow through the reaction zone countercurrently against the feed of hydrocarbon vapors, with continuous circulation of the spent catalyst through a regenerating system, the whole forming a complete cycle of cracking and revivification. The reactor and the regenerator units are designed for handling cheap catalysts having characteristics similar to the granular clays used for filtering (decolorizing) oils. The operating arrangements are designed for flexibility.

By its nature the TCC process is suitable for both catalytic cracking and catalytic phase vapor treating. It was developed before the war for cracking to produce high-octane motor gasoline; it is found equally adaptable to the production of high-octane aviation gasoline needed in the present emergency. In addition to gasoline the process yields substantial quantities of other valuable products, such as the butane-butylene fraction for charging to alkylation plants, C_5 hydrocarbons, aromatics and heating oils.

Important features of the plant design are summarized as follows: low construction and operating cost, extensive use of conventional refinery equipment, low requirement for strategic materials, use of low-pressure blowers instead of compressors for supplying the regenerating air, conversion of regeneration heat to high pressure steam, and adaptability to small as well as large-scale oil refining. Only moderate temperatures and pressures are required.

The Storage of 1:3 Butadiene—Research Bulletin No. 7.3811-B of the Mellon Institute of Industrial Research, Pittsburgh; 35 pages.

This is the report of a chemical storage fellowship sponsored by Pittsburgh-Des Moines Steel Company.

The results of this research indicate that 1:3 Butadiene should be stored at a temperature of about 32 degrees Fahrenheit at which it has a vapor pressure of approximately 3 lbs. per sq. inch gage. This conclusion is supported by the following reasons:—

1. The loss of product at 32 degrees Fahrenheit through dimerization and polymerization is practically negligible, such loss being less than 1/40 of that occurring during storage in the usual steel containers during the warm summer months.

2. Storage at about 32 degrees Fahrenheit results in the lowest initial cost of the storage plant and also the lowest total opening operating cost.

3. The amount of steel required for the containers at the recommended storage temperature of 32 degrees Fahrenheit is less than ½ of the amount required for containers in which 1:3 butadiene is stored at ambient temperatures.

4. The containers should be of maximum size for the total capacity involved, because within the range of capacities considered for rubber plants and the producers of synthetic rubber raw materials, the larger the container size the lower the cost per unit of product stored.

Much physical data and cost data are given. Various types of containers are illustrated.

Producing Acetylene by Thermal Cracking of Hydrocarbons—R. Leonard Hasche, in CHEMICAL METALLURGICAL ENGINEERING, Vol. 49 (1942), No. 7, pp. 78-83.

Laboratory and pilot plant experiments on cracking natural gasoline and liquid hydrocarbons to obtain principally acetylene with subsidiary amounts of ethylene and benzene are reported. The technique, which was worked out basically by Wolff in 1926, consists in passing the hydrocarbon at a fast rate through a highly heated tube, or, alternatively, through a previously heated regenerative furnace lined with carborundum as the refractory material. With suitable regulation of the time of contact, a temperature of about 1350° C. appears to be optimum for acetylene. At lower temperatures less acetylene and more ethylene are produced, along with some methane and hydrogen as the principal other products of the cracking operation. By separating the ethylene and recycling it, a good overall yield of acetylene is obtained, and the process becomes a low cost one in this field.

It is concluded that while the petroleum industry offers possibilities for producing butadiene by cracking, the possibility of cracking hydrocarbons to produce acetylene, which may then be converted into butadiene, has features which should not be overlooked; these features are the low cost and the purity of the butadiene obtainable by this method. In cost, especially, the thermal production of acetylene is more economical than to produce it by electrical cracking processes that have been proposed. (The author does not make a direct comparison with the old established calcium carbide method).

Aside from its use as raw material for Buna S rubber, acetylene is one of the parent substances of the chloroprene rubbers, and is assuming greater importance as the source of many important organic chemicals.

No. 2 OF A SERIES TO HELP YOU KEEP CRACKING STILLS OPERATING AT PEAK EFFICIENCY

HOW TO CARE FOR PRECISION BUILT TUBE CLEANERS

During their normal operations tube cleaners are subjected to abuse and neglect far more than other precision-built tools. To conserve them, good judgment must be used.

After a tube cleaner is used an immediate inspection of every part should be made by a competent mechanic. He should test the motor so that their proper rating can be maintained. This can be done with a simply constructed dynamometer. Worn parts should be replaced at once so that the cleaner is ready when additional use is required. Cutter heads, universal joints and other wearing parts should be checked and placed in good working order.

Insisting on such a check-up will pay big dividends in lowering maintenance cost, conserving critical materials, and in saving of time.

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To save cement and get a better cement job, always use AQUAGEL. It provides advantages which are invaluable in cementing casing.

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Corrosion Protection for Storage Tanks—F. L. Newcomb, E. S. Dixon, and C. F. Kelly, before Refining Division, AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1942.

For a number of years extensive work has been carried on developing methods of corrosion protection for steel storage tanks. Galvanized roofs have shown a life double that of plain steel for less than double the cost. Galvanized tanks, in small sizes, have shown merit. Aluminum roofs have given good service, but are costly, particularly when aluminum rafters are used. Various coatings, including aluminum and lead foil, paints, enamels, synthetic resins, etc., generally have been unsatisfactory, although they afford some protection for a short period. Use of outside rafters on small tanks has resulted in reduced replacement costs. The use of spent caustic, when corrosion is due to aqueous solutions of hydrogen sulfide, has given good results. Electrolytic corrosion of tank bottoms has been controlled successfully by cathodic protection. Most of the foregoing methods of protection require the use of critical materials not available for such use.

Concrete has been employed for many years as protection for various parts of tanks. Successful methods of applying reinforced gunite linings are described and illustrated. These have been applied successfully when the tank was in such corroded condition that replacement was the only alternative. Costs per square foot are 40 cents for roof and structural members, 37½ cents for the shell, and 35 cents for the bottom—these totaling about half the cost of a new tank. The use of unreinforced gunite lining for protection of floating-roof tanks also is described.

Gunite protection of storage tanks appears to be the most feasible means of preventing corrosion and maintaining storage tanks for the duration of the emergency.

Filtration of Oils with Prepared Magnesium Silicate—H. E. Bierce, Sr., in OIL & GAS JOURNAL, Vol. 4 (1942), No. 18, pp. 47-48.

It has been recognized for some time that many natural decolorizing clays owe their activity to the magnesium silicate they contain. This observation has lately led to the production of a synthetic material containing silicate that has color absorbing properties. This synthetic product, known as magnesol (Westvaco Chlorine Products Co.) is superior in quality and uniformity to the natural magnesium clays, as would naturally be expected from controlling manufacturing processes. The necessary raw materials, calcium chloride and magnesium chloride, are by-products from salt works. It is said to be very efficient in the decolorization of all petroleum products which can be filtered, and is relatively most efficient when used on oils of high viscosity, index whether produced from parafin-base crudes or by solvent extraction. The material is very light, weighing only 22 lbs. per cu. ft. At present it is mostly used as a fine clay for filtering, but might also be used for percolating. Treatment of acid-treated oils with Magnesol may be managed so as to bring the acid number within specifications along with the proper color. After use it can be regenerated by extraction with a solvent, and reused through 10 to 30 cycles. One Pennsylvania refinery has used this material exclusively in the filtration of all its oils for the past three years, and has obtained filtration costs that are much lower than those of any other method in a similar operation.

Equipment for Butadiene Production—J. V.

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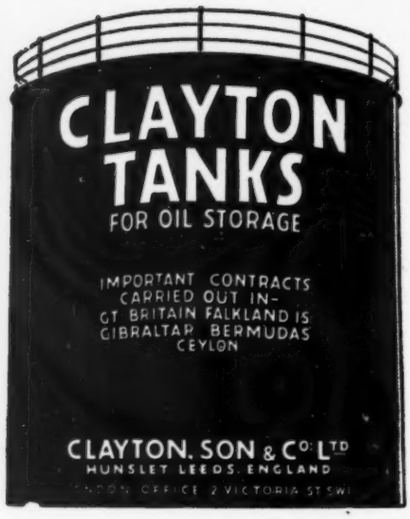

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By W. A. Gruse and D. R. Stevens
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Thorough and up-to-date, this book completely covers the chemistry of petroleum and the modern methods of petroleum production, and utilization. In the most convenient form, it provides detailed descriptions of the important types of petroleum, gives a critical comparison of the various methods of refining and distilling and processes of cracking, and includes a thorough discussion of all petroleum products and by-products.

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Hightower, in REFINER, Vol. 21 (1942), No. 4, pp. 101-102.

Although the production of butadiene, which is the critical ingredient of artificial rubber that is now being needed in large quantities requires the petroleum industry to enter a new field, not much change either in equipment or in processing will be needed.

The raw material of butadiene is from two sources: Normal butane, which exists in natural gas and is found in the stabilizer of every topping plant, and in the products of cracking plants. In either case the separation of the butane is a matter of close fractionation with equipment which every experienced still man knows how to operate. Once obtained, conversion of the butane into butadiene requires a cracking or heating operation involving mostly a matter of temperature and pressure control which is within the range of common experience. The equipment for this phase of the process will be different only in the sense that alloy steels capable of withstanding high pressures at high temperatures are required. After the cracking treatment, whether of the thermal or of the catalytic type, the products will pass through a tar stripper and other familiar fractionating equipment. The fractionation will have to be close, as only butadiene of the highest purity is suitable for the manufacture of artificial rubber. Being a volatile fluid which boils at 24° F. and has a vapor pressure of 25 pounds at 80° F., butadiene requires to be stored in pressure tanks.

A Review of Multiple-Zone Well Completions—W. A. Alexander, before Production Division, AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1942.

This paper presents representative data on multiple-zone completions which have been made in the several oil-producing regions of the United States. It is a joint effort of the Topical Committees on Drilling and Production Practice, and constitutes a progress report on the subject.

The desire of the oil industry to find ways and means of conserving steel in its drilling and production activities led to the decision to undertake this survey. An analysis of 89 multiple-zone completions indicate that an average per-well saving of 105 tons, or 46 per cent, was realized in a multiple-zone completion, in comparison with 2 standard well completions.

Available information indicates that the initial completion of wells in more than one zone can be accomplished successfully. Reliable data on the effectiveness of the method are at present limited to the earlier stages of multiple-zone production. Sufficient representative data on the later life (especially during the artificial-lift period) of multiple-zone wells are not yet available to permit drawing any definite conclusions as to the ultimate overall practicability of the method.

PHYSICS

Specific Gravity of Petroleum Oils by the Falling Drop Method—A. J. Hoiberg, in INDUSTRIAL ENGINEERING CHEMISTRY, Analytical Edition, Vol. 14 (1942), No. 4, pp. 323-325.

A method of densimetry which has shown many advantages in determinations with body fluids has been modified to adapt its use to measurement of the specific gravity of petroleum oils. Operation is rapid and easy, since the procedure depends only on the measurement of the time of fall of a drop of oil in an alcohol-water solution. The specific gravity is then determined by direct conversion of the time of fall from a calibration curve for the solution. This method has been found accurate to within ±0.0010 unit of specific gravity. Since only a few drops of the petroleum fraction are required, the determination may be made on the very small volumes of oils often obtained in analytical distillations or extractions.

USES

Increased Fuel Economy Through Operation on a Reduced Number of Cylinders—A. Ludlow Clayden and J. G. Moxey, in report to Sun Oil Company, August, 1942.

As a contribution to the vital subject of making reduced supplies of gasoline last longer or go farther, the Sun Oil Company has released this report of its engineers on the operation of automobile engines with only half the cylinders in action. Exhaustive road tests with 4, 6, and 8 cylindered engines of various makes showed that the fuel economy at 20 miles per hour was as much as 51 per cent in some cases, and appreciable in practically all cases, even at higher speeds. Information on how to make the necessary changes in the engine is given.

BOOKS

The Oil and Gas Industry of Colorado, by Clark F. Barb, published 1942 by Colorado School of Mines, Golden, Colo., as Vol. 37, No. 2, of Colorado School of Mines Quarterly; paper, 129 pages, with tables and map; $2.00.

This volume is intended as a source of information concerning various phases of the oil industry of the State of Colorado; for this purpose the author has assembled facts and knowledge that has heretofore remained scattered through the literature and in the files of companies and individuals.

The first portion of the work outlines the general history and geology of the state, and with the aid of a large map locates the oil and gas wells and as many wildcat wells as could be found. The 25 recognized oil and gas fields are described, and this section is followed by a discussion of oil and gas reserves, and the cost of oil production. The 10 refineries are described next, together with observations on miscellaneous subjects, such as crude oil analyses, oil consumption, markets and pipelines, followed by a bibliography. There are 16 tables of statistics and information, and 29 text maps and illustrations. Anyone interested in Coloradan oil should have a copy of this publication.

Oil in the Earth, by Wallace E. Pratt; published 1942 by University of Kansas Press; 105 pages.

This small book comprises four lectures delivered before the students of the department of geology his intention not to tell geology students something they have already learned from their professors and their text books, but to tell them something of his own experience in the field of oil finding; and when an eminent petroleum geologist like Pratt

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The Chemical Technology of Petroleum.—By William A. Gruse and Donald R. Stevens; published by McGraw-Hill Book Co., New York; 733 pages; $7.50.

This book was formerly published (1928) under the title, "Petroleum and its Products," and was devoted to the chemical interpretation of the facts known about petroleum and its utilization. In the meantime there has been a renaissance of the chemistry of aliphatic chemistry, and a new technology of petroleum has arisen.

The first portion of the book, covering 233 pages is a survey of the characteristics of petroleum as it occurs in the various oil-bearing regions of the earth; the classification of petroleum hydrocarbons, their chemical compositions, group reactions, and physical properties. Then the discourse proceeds to distillation, refining by chemical and physical methods and cracking, with a chapter on the chemical thermodynamics of petroleum hydrocarbons. The chemical and refinery aspects of gasoline, kerosene, lubricants and lubrication, paraffin, waxes, fuel oils, petroleum asphalts, and miscellaneous petroleum products and by-products occupy most of the remainder of the work. Physical properties of petroleum hydrocarbons are shown in a table of 48 pages, and there is a comprehensive index.

The book is intended to help investigators and advanced students to find their way about in the newly opened and vast science and technology of oil. The authors have not ventured to carry their subject into the chemistry of petroleum-derived artificial rubbers but in other respects their work is up to date.

Static Defense of Strategic Oil Installations—by Orchard Lisle; published 1942 by Scribner's, New York; $1.00.

This is a small manual dealing with the protection of oil properties in view of war hazards, particularly bombing raids. The author has drawn considerably on European experience in the current war, as well as recommendations of American experts. The subject is divided into two parts. In the first part consideration is given to the nature and powers of the bombs likely to be dropped by the enemy, both for incendiary and demolition purposes, and the preparations and constructions that are best adapted to minimize their effects. The second part describes various means of concealment and protective coloration (camouflage) to deceive or mislead the enemy aviators. The work is illustrated with photographs and drawings of typical arrangements.

Petroleum Development and Technology, 1942—Prepared by the Petroleum Division of the American Institute of Mining and Metallurgical Engineers and published by the Institute, New York; 565 pages; cloth, $5.00.

This annual contribution to petroleum information consists, as usual, of papers by members of the Division and previously published in *Petroleum Technology*. These papers relate to topics in Production Engineering, Engineering Research and Petroleum Economics. The larger portion of the book is devoted to an extensive review of oil production in the United States and some foreign countries. The fifth and closing chapter is a review of refinery engineering for 1941, by Walter Miller.

GENERAL

Formaldehyde From Natural Gas—Anon. CHEMICAL AND METALLURGICAL ENGINEERING, Vol. 49 (1942), No. 9, pp. 154-159.

The growing importance of the petroleum industry in the chemicals field is again illustrated in the large-scale production of formaldehyde, methanol and related chemicals by the direct oxidation of natural gas hydrocarbons at the Tallant, Okla., chemical plant of the Cities Service Oil Co.

Conversion of methane and other natural gas hydrocarbons directly to formaldehyde by air oxidation has received much attention in the past, but

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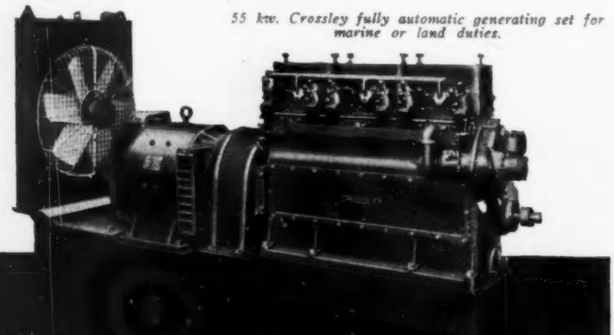

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the first successful commercial plant utilizing this method was built at Tallant early in 1928. Since that time, the production capacity of this plant has been consistently expanded. Output at present is very substantial. Cities Service today is the largest producer of formaldehyde by this process —a process developed by its own research organization.

A substantially equal tonnage of methanol is produced simultaneously with the production of formaldehyde. A smaller tonnage of acetaldehyde, methyl acetone solvents, etc., are also produced. These products are produced in admixture—as a crude chemical—by the controlled partial oxidation of natural gas hydrocarbons. The crude chemical product must then be separated by fractionation into its major constituents—formaldehyde solution, methanol, acetaldehyde, and methyl acetone solvents. These fractions are further refined to commercial specifications. Methanol produced in this process has been converted largely to an antifreeze, but substantial quantities have now been made available to other uses.

This process for the manufacture of chemicals operates at moderate temperatures and pressures and therefore does not require the expensive forgings and other scarce materials essential to synthetic processes operating at pressures of several hundred atmospheres.

The Effect of Camouflage Painting on the Temperature of Plant Equipment—Oliver W. Johnson, before CALIFORNIA NATURAL GASOLINE ASSOCIATION, August, 1942.

In the peaceful past light colored paints have been almost universally employed for painting gasoline plant and oil refinery equipment. This practice has been based largely on the fact that light colored paints absorb less heat and keep down evaporation lost in oil and gasoline plants. These paints, however, make the plant quite conspicuous to bombers in the air, and since the outbreak of hostilities much thought has been given to protective coloration of military objectives, which oil installations now are.

The object of camouflage, or protective colorations, is to destroy color contrasts on which aviators, and particularly aerial photographers, depend. Hence light colored objects are toned down so that they blend with the general color of the surroundings. Thus, a white building among trees would be painted a neutral green. This, however, will not fool a photographic plate unless the pigment of the green paint is one that does not reflect the infrared rays of sunlight; hence it is necessary to camouflage buildings with paints that reflect light in the same manner as the surroundings. The only way to select the proper camouflage paint is to determine the character of the terrain photographically, and this is a matter for experts.

Paint manufacturers have expended much effort in compounding colored paints that will not reflect infra-red rays and at the same time absorb the least possible heat. A number of such paints have been tested, and it appears that about the best that has been done is to produce colored paints that will not increase the amount of heat above about twice the amount absorbed by white or aluminum paints.

Present Allocation Practices.—D. R. McKeithan, before PRODUCTION DIVISION, AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1942.

The development of allocation methods in the various oil-producing states is reviewed and analyzed; also a brief description of the administration and mechanics of the systems employed is presented.

Conclusions drawn therefrom are:

1. The oil industry is operated primarily on a competitive basis, and this factor adds to the complexity of the attainment of maximum efficiency in conservation, and allocation is extremely difficult.

2. Systems of control in the various states are geared to meet local operating conditions as well as background and temperament of the people in conformity with American standards of localized government.

3. The actual mechanics of allocation used in the various states differ greatly and, further, it appears that one basic law or one rigid formula cannot be applied reasonably to all the varied conditions.

Vast strides toward general improvement have been made in recent years; however, there is still room for considerable betterment; and the "Standards of Allocation of Oil Production Within Pools and Among Pools," as set out in the report of the American Petroleum Institute's Special Study Committee on Well Spacing and Allocation of Production, should be of material assistance in further progress.

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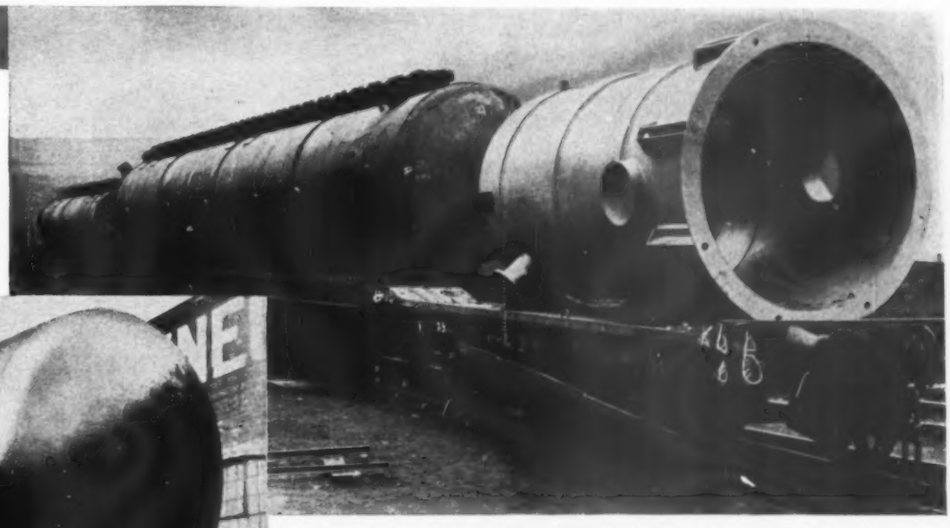

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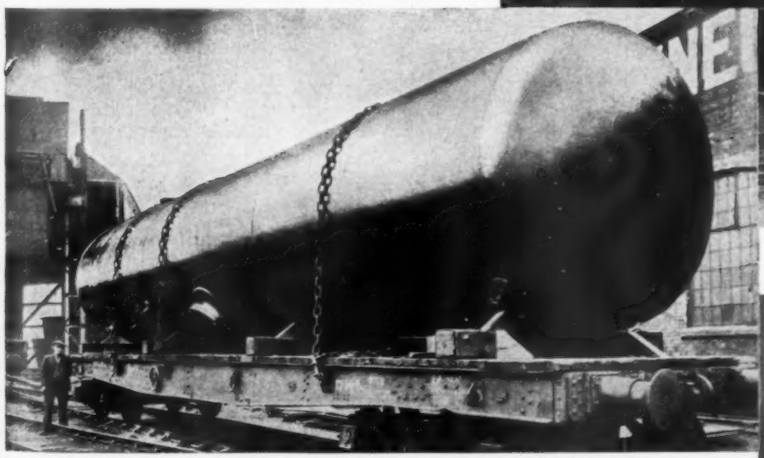

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OIL INDUSTRY PROGRESS IN ARGENTINA

REPORT OF Yacimientos Petroleras Fiscales, government controlled oil company of Argentina, for the year 1941 shows a substantial improvement in production over the preceding year, practically equaling the peak figures of 1936. At the end of the year there were 2,150 wells producing oil in all the government fields and 44 gas wells in production or in reserve.

Total production of crude oil was 14,006,558 bbl., an increase of 12.3 percent over 1940; it would have been more if delivery of essential materials ordered from abroad could have been obtained. Production in Commodoro Rividavia showed an increase of 7.9 percent, Salta 19.6 percent, while the largest increase was in Mendoza, 33 percent. Production in Plaza Huincul fell off by 125,592 bbl. due to greater attention paid to other fields. Two new refineries began operations during the year. One at Lujan de Cuyo (Mendoza) and the other at Chachapoyas (Salta); both went into production with capacities exceeding the guarantee of the contractors. The six existing refineries processed a total of 14,212,475 bbl. of crude, which exceeded the preceding year's throughput by 953,821 bbl. Of the total refinery throughout 85 percent was native crude and 15 percent was imported crude.

Total gasoline production was 3,509,000 bbl., an increase of 7.72 percent, with corresponding increases in other refined products. Production of three new types of lubricants has been begun. A new and well equipped petroleum research laboratory has been completed at Florencio Varela. Work is well advanced on a new pipe line to supply gas to Buenos Aires from the Distilleria de la Plata. New sortage depots have been installed at Dorsena Sur and San Lorenzo.

Lack of storage prevented the importation of 100,000 tons of badly needed fuel oil. The severity of the fuel situation is indicated by the diversion of large quantities of corn on the cob to fuel purposes. The ears of corn are coated with asphalt at the refinery and sold under the name "Maizasfal" to railroads and other fuel users. To help out the fuel situation the YPF has been commissioned to make an intensive study of minable coal fields, and is arranging with the provincial governments of Mendoza and Salta for the development of hydroelectric power.

Drilling in old and in wildcat oil territory totaled 870,147 feet, 22 percent more than in 1940. Several old fields were extended and it seems that one important new field, not yet fully defined, has been found near Challaco Station on the F.C.S. railroad. Twenty-two drilling rigs were in operation; they drilled 103 test wells for a total of 360,979 feet. Much prospecting, both by gravimeter and by seismograph, as well as much topographic surveying, has been carried on; a number of gravimetric anamolies have been discovered in Mendoza and favorable structures in other districts.

REJUVENATING OLD STORAGE TANKS

A METHOD for repairing bottoms of old oil storage tanks that cannot be replaced in these times when new steel is hard to get is thus outlined by the Chemical Research Corporation, of Wichita: a steel shell concentric to and two inches distant from the inner circumference of the tank is anchored to the tank bottom and extends up to the level of the pipe line openings. The annular space between shell and wall is then filled with Resistal plastic cement. The tank bottom, previously cleaned, is given a special priming coat and then a one-inch layer of the Resistal cement the whole is then given a final spray coat of Resistal M-600. This installation provides an effective defense against the corrosive action of brines charged with sulfur dioxide and hydrogen sulfide. The plastic cement eliminates all further corrosion and leaks in the chime and lower ring; even large holes in the side sheets and bottom plates may be effectively covered up. The Resistal cement used in this work is a nonflammable organic lacquer-like material of great elasticity which has excellent dielectric properties. It absorbs no moisture, is insoluble in water and in aliphatic hydrocarbons, does not become brittle and is unaffected by strong acids or alkalies. Tanks so reclaimed may have a long lease of life, depending on the severity of the circumstances.